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ORIGINAL ARTICLES.

I.—On some Fossil Estheriæ.

By Prof. T. Rupert Jones, F.R.S., F.G.S., etc.

(PLATE XII.)

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    2. *E.* sp. undescribed.

A. Triassic Estheriæ.

I. *North-American Estheriæ.*

1. Estheria Lewisii, sp. nov. Pl. XII. Figs. 3*a*, 3*b*.

THIS species is represented by one cast and part of another, in red sandstone from Bucks Co., Pennsylvania, given to me not long before his death by my lamented friend, Professor Henry Carvill Lewis, F.G.S., etc., of Philadelphia.

Length 5 mm. Height 3 mm.

Valve narrow-subovate or oval-oblong; straight above (hinge-line to length of valve nearly as 23 to 30), neatly curved below, though the edge is not quite perfect; rounded at the extremities; umbo strong, a sixth of the valve's length from the front end. The concentric ridges of the surface, 19 or 20, strong and wide apart in the early part of the valve, closer but very distinct afterwards. The casts seem to show traces of interstitial markings in irregular vertical lines (Fig. 3*b*); but unfortunately these are partly due to the sand-grains of the matrix and the partial coating and staining of iron-oxide.

As this form differs from any other known, I propose to regard it as a new species, *Estheria Lewisii*, dedicated to the memory of one of the most promising and most regretted of geologists. His short life and brilliant works are recorded in the Geol. Mag. for September, 1888.

A brief account of the geology of Bucks County, Penna, whence Prof. H. C. Lewis received the specimens of *Estheria Lewisii* here described, is given by Prof. J. P. Lesley in the "Geological Hand Atlas of the Sixty-seven Counties of Pennsylvania," etc, in the

"Second Geological Survey of Pennsylvania: Report of Progress, X." 1885. At pages xxviii and xxix it is stated that "most of its surface is a gently rolling, highly cultivated country of Mesozoic New-Red sandstone and shale, all dipping north-westward at angles varying from 5° to 15°, for 33 miles (in a straight line) along the river [Delaware] . . . . . The Mesozoic formation is of the same character throughout,—an alternation of hard and soft layers of reddish sand and mud, some fit for building-purposes, some conglomeratic, a few calcareous, and some (near the middle of the formation) fossiliferous, containing numerous bones of large sea-lizards, shells, and plants."

2. Other North-American Estheriæ.

The best of Prof. Lewis's specimens (Fig. 3*a*) is unlike any of those from North America figured in pl. 2 of the "Monogr. Foss. Estheriæ, Pal. Soc." 1862. Among the woodcuts of these Estheriæ, copied at pp. 86-7 of the "Monograph," fig. 6 (*Estheria ovata*, Lea, sp.; *Posidonia multicostata*, Emmons) is the nearest in shape, but differs in the number of concentric riblets. Fig. 8 (*E. ovata*, Lea, sp.; *P. ovalis*, Emmons) has the concentric lines more similar, but the outline is very different. My statement, that these and the other woodcuts are of little or no use towards the discrimination of species, unfortunately still holds good. I suggested at p. 91, that fig. 28 of pl. 2 may be the same as figs. 26 and 27, the shape being the same; the first-mentioned, however (figs. 28–30), has not only very close-set concentric lines of growth, but *smooth* interspaces; and fig. 31 shows the same feature, sufficient to characterize a species. Unfortunately we have no certainty about the interstitial ornament of the wide-ribbed figs. 26, 27. Nor can we refer the reticulate ornaments, figs. 32, 34, 35, 36, so much like that of the European *E. minuta*, and fig. 33, corresponding with that of *E. Brodieana*, to any known form from Pennsylvania, Virginia, or North Carolina. Much less the ornaments shown by figs. 37 and 38 of pl. 2. These isolated pieces of ornament were taken from parts and pieces of badly-preserved North-American *Estheriæ*, and probably indicate five or six different species. Figs. 26 and 27 may very well represent one of these species, most likely one with *reticulate* interspaces; but there is as yet no proof of this relationship.

The following Table shows the leading characters of the North-American fossil *Estheriæ* figured in pl. 2 of the "Monogr. Foss. Esth. Pal. Soc." 1862:—

Fig. 26, 27. From Prince Edward, near Richmond, Virginia ...	Concentric lines wide apart.
,, 28. Harding's pit, near Richmond	Concentric lines numerous and close together.
,, 29 and 30. The same	Smooth interspaces.
,, 31. Richmond	The same.
,, 32. Richmond	Reticulate interspaces, like those in *E. minuta*; probably somewhat squeezed cross-wise.
,, 33. Richmond	Small reticulation, like that in *E. minuta*, var. *Brodieana*.

Fig. 34. Dan River ..... { Reticulation, like that of fig. 32, and probably slightly squeezed in the same way.

„ 35. Dan River ..... Similar reticulation, but squeezed obliquely.

„ 36. Richmond ..... { Similar reticulation, either squeezed sideways, or naturally crossed with slight vertical ridges.

„ 37. Dan River ..... { Columnar interstitial ornament, like that in some Wealden specimens, and in the recent *E. similis*.

„ 38. Richmond ..... { Interspaces filled with coarse parallel thread-like lines, one separated from another by a row of small pits.

Figs. 26 and 27 are good examples of subovate valves, with open concentric ribbing, but have lost all trace of their interstitial ornament; fig. 28, though of the same shape, differs from the foregoing in the closeness of its lines of growth.

The ornamentation shows that figs. 32, 34, and 35 are decidedly of one species; fig. 33 may be a variety of the same; fig. 36 is either the foregoing large reticulation squeezed sideways, or that of a different species; fig. 37 and fig. 38 are also distinct species.

We have no better grounds for taking these characters of imperfect specimens as the basis for *naming* the possible species than we had in 1862, when I grouped them all under Lea's name "*ovata*," on account of the possibility of bad drawings of badly preserved specimens making differences where none really exist.

Prof. J. D. Dana, in his "Manual of Geology," 3rd edit. 1880, p. 410, gives in fig. 711 a drawing like fig. 5 (Lyell's woodcut), p. 86, Monogr. Foss. Esth., for *E. ovata* (Lea); in fig. 711*a*, *E. ovalis* (Emmons), like the fig. 8, p. 87, *op. cit.*; and in fig. 711*b*, a small, neat, suboval valve (apparently the same as "*Estheria ovata*," fig. 261, p. 169, "Text-book of Geology," 1870) as *E. parva* (Lea). This is an acceptable plan, if "*E. ovata*" can be allowed (as in 1862) to cover the group, although Emmons's *multicostata* was said by Conrad to be the same as Lea's *ovata*; the latter to be apparently not the same as Lyell's specimens (fig. 5, p. 86, Monograph, & pl. 2, fig. 28); and Emmons's *triangularis* (p. 86, fig. 7) to be probably the same as Lea's *parva*. We still want perfect drawings or good examples of these forms. Prof. H. Carvill Lewis hoped to get some for examination; but the specimens now before us are all that opportunity permitted him to obtain before he was taken from us.

II. *Estheria minuta* (Alberti), and *E. laxitexta*, Sandberger, from Bavaria, etc.

Some years ago my friend Dr. Fridolin von Sandberger favoured me with several specimens of *Estheria minuta* (Alberti) and *E. laxitexta*, Sandberger, but it has been only of late that I could take them in hand for careful examination. The following have been selected as specimens showing good shapes of *E. minuta*.

Figs. 4, 5, and 6 are in a grey, micaceous shale, with ferruginous impressions of plant-remains, from the Lettenkohle, at Fulda, Hessen-Cassel.

Fig. 4 corresponds closely with fig. 4, pl. 2, "Monogr. Foss. Estheriæ," 1862, but has rather weaker umbo and stronger concentric wrinkles; Fig. 5 is like fig. 29, pl. 1, but is weak in the umbo (like Fig. 4), and has more numerous and less pronounced concentric

wrinkles; in its straight back and feeble lines of growth it is like fig. 5, pl. 2, but its postero-ventral curve is much fuller. The little Fig. 6 matches fig. 14, pl. 2, the small Rhætic variety *Brodieana*, but it has not quite so prominent an umbo, and is rather squarer in outline.

Fig. 7, labelled "*E. Albertii* (Voltz), Baden," is in a hard micaceous shale, light-grey and purplish; it is not much larger than fig. 9, pl. 2, and differs only triflingly in outline, being rather fuller in the antero-ventral curve, less angular in front of the umbo, and having slightly stronger concentric ridges. With its relatively small size and oblong shape Fig. 7 ($4\frac{1}{2}$ by 3 mm.) comes in as a large form of var. *Brodieana*. It is from the upper red clay of the Grès bigarré, at Durlach, Baden.

In a piece of thin, dull-red shale from the Pfinzthal, Baden, is a shining, compressed cast of another specimen, labelled "*E. Albertii* (Voltz)," similar to Fig. 7, and measures 4 by 3 mm.

On one of the bed-planes of an inch-thick mudstone, dark-grey, hard, fine-grained, and slightly micaceous, from the Lettenkohle of Würzburg, Bavaria, are numbers of a small form of "*Estheria minuta*" (about 4 by $2\frac{1}{2}$ mm.) crowded together. On the other bed-plane is a group of *Pullastra*-like bivalves in casts and impressions.

Fig. 8, labelled "*E. laxitexta*, Sandberger, from the Estheria-bed of the Lower Keuper, at Windsheim, Middle Franconia," is a fine large *Estheria* with shape and ornament like those of *E. minuta*, Fig. 8*a* is comparable with fig. 5, pl. 2, of the "Monogr. Foss. Esth." 1863, though somewhat larger, and having a fuller curve at the antero-ventral margin. The reticulate sculpture of the concentric interspaces is essentially the same as that in figs. 3 & 7 of the pl. 2 referred to, so that I cannot find good ground for following Prof. Dr. Fr. von Sandberger in separating this form from *E. minuta*. He tells me in a letter (May 8th, 1890), that he "separated *E. laxitexta*, which occurs high above the stratum with *E. minuta*, from that species on account of the difference in the sculpture; that he has not described nor figured it; and that its relatively larger size was not the reason of his separating it from *E. minuta*." Certainly the slight difference in size and contour is not sufficient for a specific distinction; and the sculpture of the selected specimen shows no difference.

E. laxitexta was mentioned by Dr. von Sandberger in the "Verhandlungen d. k. k. geol. Reichsantalt" (Wien), No. 16, 1871, p. 323, in a note on the Estheria-bed of the Keuper in South France; but, by some mistake, it is there stated to have been described, from English specimens, by me, as a variety of *E. minuta*, occurring exclusively in the Lettenkohle.

Some of the specimens before me are numerous and relatively well preserved on the bed-planes of a greenish shale, rather hard and slightly micaceous, from near Bayreuth (Upper Franconia) and in the Steigerwald, like (von Sandberger states) the Estheria-bed of the Keuper in Swabia and in the Department Gard in South France. Others lie less regularly in a grey, harder, and more solid mudstone

or shale, slightly micaceous, from the Lower Keuper of Windsheim, Middle Franconia (Bavaria).

B. Purbeck Estheriæ.

1. Estheria subquadrata (Sowerby). Pl. XII. Figs. 1, 2*a*, 2*b*.

Estheria elliptica, Dunker, var. *subquadrata* (Sow.), Monogr. Fossil Estheriæ, Palæont. Soc. 1863, pp. 103–109, pl. 3, figs. 18–29.

	Length.	Height.
Fig. 1.	5·6 mm.	4·0 mm.
Fig. 2.	4·5 mm.	3·8 mm.

Doubtless there is a close zoological connection between *Estheria elliptica*, Dunker, and *E. subquadrata* (Sow.), but it now appears to me, especially as no specimens exactly like Dunker's type ("Monogr. Foss. Esth." pl. 4, fig. 1), nor its most quadrate variety (fig. 3), have been met with in England, that it will be advantageous to palæontologists for us to allow the slight difference in outline, and the more striking difference in the interstitial ornamentation, to constitute specific (and not merely varietal) distinctions, and thus allow *E. subquadrata* to stand by itself as a species.

The specimens collected by the Rev. W. R. Andrews, F.G.S., in the Vale of Wardour, and kindly submitted by him for examination five or six years ago, comprise an internal cast retaining only a small remnant of the test, Pl. XII. Fig. 1, and a perfect, but smaller, individual, Fig. 2*a*, *b*. In Fig. 1 we have an oblong form, with advanced anterior angle, and a nearly vertical, slightly convex front edge. This is proportionately shorter than fig. 23 in pl. 3, "Monogr. Foss. Esth.," and more fully curved on the ventral margin; but its long back distinctly separates it from fig. 3 of pl. 4 *op. cit.*

In our Fig. 2*a* we see the nearly exact counterpart of fig. 19, pl. 3, of the Monograph, with an ornament corresponding more or less closely with that of figs. 21, 22, 24, 28, and 29 (from the Wealden of Sussex), but not with that of the Hanoverian specimens (pl. 4, figs. 4, 5, and 7).

These specimens (Figs. 1 and 2, sent to me about 1884) occur in a brownish sandy (Middle-Purbeck) stone, a little above the top "lias" of the Purbeck beds, in the limestone-quarry, at Teffont-Ewyas; and the same form is abundant in specimens (sent in November, 1888) of a Cypridiferous limestone on the same horizon, a little below the "Cinder," and therefore also from the Middle Purbecks. In the sandy bed fragmentary twigs of a *Thuia* occur; and in the limestone *Cypridea punctata* is plentiful, with *Cyprione* (probably *C. Bristowii* and another), and *Metacypris* (?). This Estherian limestone was from a small quarry on the railway south of the River Nadder, at Lower Chicksgrove, about two miles west of the Rectory where the Rev. W. R. Andrews resides.

2. Lately Mr. Andrews has discovered some other *Estheriæ*, larger in size, and with a different ornamentation, and therefore of a distinct species, in a band of black and brown shaly clay, with the Middle-Purbeck *Cypridea fasciculata*, five feet below the horizon of the *Estheria subquadrata* mentioned above, and in the same quarry as that in which the specimens shown by Figs. 1 and 2 were found.

EXPLANATION OF PLATE XII.

FIG. 1. *Estheria subquadrata* (Sow.). Internal cast of a right valve; not quite perfect; × 6 diam.

,, 2. ——— *a*, Right valve of the young form or variety; × 6 diam. *b*, Interstitial ornament; × 50 diam. Figs. 1 and 2 from the Vale of Wardour.

,, 3. *Estheria Lewisii*, sp. nov. *a*, Internal cast of a right valve, rather compressed; × 6 diam. *b*, Imperfect traces of interstitial ornament; × 70 diam. From Pennsylvania.

,, 4. *Estheria minuta* (Alb.). Left valve; × 6 diam.

,, 5. ——— Right valve of an individual with numerous lines of growth; × 6 diam.

,, 6. ——— Right valve of the small variety *Brodieana*; × 6 diam. Figs. 4, 5, and 6, from the Trias at Fulda, Hessen-Cassel.

,, 7. ——— Left valve of a small or young individual; × 6 diam. From the Trias of Baden.

,, 8. ——— (*E. laxitexta*, Sandb.). *a*, Left valve of individual with numerous lines of growth; × 6 diam. *b*, Interstitial ornament of another specimen; × 50 diam. From the Trias of Bavaria.

,, 9. *Estheria membranacea* (Pacht). *a*, Right valve of an individual of the long variety; × 6 diam. *b*, Interstitial ornament (unusually well preserved); × 50 diam. From the Old Red of Orkney.

II.—VERTEBRATE PALÆONTOLOGY IN SOME AMERICAN AND CANADIAN MUSEUMS.

By A. SMITH WOODWARD, F.G.S., F.Z.S.,
of the British Museum (Natural History).

IN the Palæontology of the Vertebrata, so much has been accomplished on the American Continent within recent years, that any European interested in this line of research is naturally attracted to the Museums and collections across the Atlantic. Among others, the writer of the present notes has at various times been desirous of comparing certain American and Canadian discoveries with those now familiar to workers in the Old World; and this desire having lately been gratified, it may not be uninteresting to offer a few remarks on the collections of extinct Vertebrata in the New World, viewed from the standpoint of one who has had the privilege of visiting many of the corresponding collections in Europe.

NEW YORK.

The Geological Museum of the Columbia College, New York, due to the labours of the present Professor, Dr. J. S. Newberry, comprises the finest collection of American Palæozoic Fishes hitherto brought together. The Museum occupies the upper storey of the new School of Mines, and is thus well lighted from above; while the cases are small and conveniently arranged for study. The lecture room immediately adjoins, and the only inconvenience is the close proximity of the railroad—a much more noisy neighbour than its English counterpart. The large majority of American Palæozoic Fish-remains (except Selachian teeth) having been made known in the works of Dr. Newberry, the collection is especially rich in type-specimens; and the fine case of *Dinichthys* with its allies, well mounted for exhibition, is a display such as none of the well-known Scottish series of Placoderm fishes can equal. The collection is still

being rapidly augmented, and all the more important of the latest acquisitions are described in Dr. Newberry's new volume just issued by the U. S. Geological Survey.

The bones of *Dinichthys* and its allied genera usually occur in a black shaly matrix, from which they can be completely extricated; and they are often associated in natural groups, the plates of a single individual being met with together, though difficult to disinter intact on account of their huge dimensions. To one accustomed to the skeleton of the common *Coccosteus*, the remains of the American fish appear as magnified representatives of familiar bones; and other equally gigantic modifications of the same type have lately been named *Trachosteus* and *Titanichthys*.

Next to the Placoderm Fishes, the most striking of recent acquisitions are nearly complete examples of one of the Carboniferous sharks whose teeth have long been known under the name of *Cladodus*. Though showing some remarkable features,—such as a ring of circumorbital plates, abbreviate pectoral fins, and a diphycercal tail with a pair of great horizontal expansions of integument at its base,—the fish invariably rests upon its back (having been round-bodied), and thus gives no clue to one interesting character, *i.e.* the presence or absence of dorsal fin-spines. Among other unique types is the Devonian *Onychodus*, with the strange coil of spike-like teeth undoubtedly fixed in front of its lower jaw; and all the bones of this fish are so remarkably scattered that it is still difficult to form any conclusion as to its affinities. Numerous jaws of Devonian Chimæroids, the spines of *Machæracanthus*, and various remains of small Placoderms are also almost unique; and among the Carboniferous Limestone fossils are numerous types of Selachian spines and teeth. Of the latter, the great teeth named *Archæobatis* are perhaps most conspicuous; and these, it will be observed, differ in no respects from the British teeth assigned to *Psammodus*, except in the coarser nature of their coronal ornament. A large series of Cœlacanth, Palæoniscid, and other fishes, with several Amphibia, from the Coal-measures of Ohio, forms the type collection described by Profs. Newberry and Cope in the Reports of the Geological Survey of Ohio. Still higher in the geological scale, another fine collection of fishes illustrates the American Trias; and this, again, has been made available for reference by the Professor's well-illustrated volume published by the U. S. Geol. Survey in 1888. Many of these specimens were obtained from an excavation specially made at Boonton, New Jersey, which not only enriched the Museum with material, but added greatly to previous knowledge of the fish-fauna in question.

The American Museum of Natural History, in the Central Park, though as yet insignificant when compared with the plan for its completion, already comprises fine, lofty exhibition galleries and work-rooms, and, in addition, is provided with the largest and most completely fitted lecture theatre that has hitherto been built in conjunction with an institution of this kind. Each spring and autumn, the theatre is occupied by Prof. Bickmore, who delivers

a series of free lectures, illustrated by the lantern, to the Teachers of the Public and Normal Schools in the State of New York. The lantern slides are largely prepared by the Museum, and the syllabus comprises not only pure Natural History, but also subjects in Geography. General public instruction is also one of the main objects in all the exhibition galleries, and the collection is displayed accordingly. In the Geological Department, for example, under the charge of Prof. R. P. Whitfield, a series of table-cases is exclusively devoted to the illustration of Dana's well-known Manual, of which a copy is kept for the use of visitors. At the same time, the Naturalist is not forgotten, and there is probably no Museum of equally recent foundation that possesses a more representative collection or more valuable type-specimens. Among Vertebrates, the Mastodon and Irish Deer form conspicuous centre-stands; but the other remains are comparatively small and scattered through the collection, which is arranged stratigraphically as a whole, with zoological divisions in each of the various stages. The principal series of types was obtained from the James Hall Collection, which comprises many Mammalian remains from the Tertiary Formations of the West, and numerous examples of American Devonian Fishes. The former are described in Prof. Leidy's "Extinct Mammalian Fauna of Dakota and Nebraska"; while the latter have been studied by Prof. Newberry, and employed in various publications. The type specimen of *Sauripteris* made known by Prof. Hall, from the Catskill Group, is one of the most conspicuous of the ichthyolites, and doubtless pertains to the family recognized in Britain under the name of Rhizodontidæ; while another unique fossil is a cranial shield of the Placoderm *Asterosteus*, showing the laterally placed orbits, large narial openings, and a pineal foramen.

Princeton.

The collection of extinct Mammalia in the University of Princeton, New Jersey, has become well known through the researches of Professors Scott and Osborn, and is beautifully mounted and labelled in the E. M. Museum ("E. M." being the initials of a benefactress). The larger and more prominent specimens are placed on a central platform; while the smaller and more delicate objects are arranged in an adjoining series of wall-cases. Conspicuous among the large specimens, is the complete skeleton of a remarkable Deer, from the Pleistocene of New Jersey, intermediate between the true *Cervus* and *Alces*, and described by Prof. Scott under the name of *Cervalces Americanus*. Accompanying this are two fine skulls and the greater portion of the fore- and hind-limbs of *Uintatherium*, from the Bridger Eocene of Wyoming; the shell of a large Tortoise (*Hadrianus Corsoni*) also from the Bridger Eocene of Wyoming; and an American Mastodon, besides a French Cave Bear and an Irish Deer. An unique skeleton of the Creodont *Mesonyx*, described by Prof. Scott, is shortly to be mounted and added to the exhibition series from the Bridger Eocene, which is especially well represented in all groups. A goodly number of the well-known fishes of the Green River Shales

is also exhibited; and the collection of typical European fossils (chiefly due to Prof. Henry A. Ward, of Rochester) is especially complete, affording valuable material for comparison. The Professors at the present time are extending their researches to the fossil Mammalian collection of the Agassiz Museum, Cambridge, placed at their disposal by Prof. Alexander Agassiz; and portions of the results of their researches have already appeared in the Cambridge Bulletins.

Philadelphia.

Two centres of attraction to the Vertebrate Palæontologist exist in Philadelphia—the Museum of the Academy of Sciences, and the private collection of Prof. E. D. Cope. Neither of these collections is at present displayed to good advantage, but there is a prospect shortly of both being accommodated with convenient rooms and cases. The foundations of the new Museum at the Academy are already laid; and the Pennsylvanian University is preparing adequate accommodation for the collection of Prof. Cope, who has lately been appointed to its Chair of Geology.

The gem of the Academy Collection is the original specimen of *Dromatherium sylvestre*—a mandibular ramus in black coaly matrix from the Trias of Chatham Co., N.C. Its parts are as distinctly shown as in any of the Mesozoic mammalian jaws from England. Another unique specimen is the head of the Cretaceous Crocodile of New Jersey, *Thoracosaurus neocæsariensis*. This is also well preserved and shows most distinctly the true antorbital vacuities (described by Prof. Leidy), which some would erroneously explain as mere fractures. The Cretaceous Dinosaur, *Hadrosaurus*, is represented by the fine series of bones upon which Prof. Leidy originally founded the genus; but these are not shown to advantage in Waterhouse Hawkins' plaster restoration, which still survives, with the exception of the pelvis. The earliest series of fish-remains from the American Devonian and Carboniferous, described by Prof. Leidy, occupies part of one of the wall-cases, and comprises many interesting fragments; while most of the teeth and scales from the Cretaceous of New Jersey and the Phosphate Beds of South Carolina, made known in the same Professor's well-known memoirs, are arranged on adjoining shelves. A very large number of Tertiary Mammalian remains, including, among others, the type-specimens of *Megalonyx*, are placed in other cases; and Prof. Leidy is at present resuming the early researches to which these specimens bear witness, by investigating a large collection of Mammalian bones lately brought by Mr. Joseph Willcox from Florida. The collection of British Fossils is extensive and affords useful material for comparison, having been acquired by the Academy from Dr. T. B. Wilson. There are many interesting Old Red Sandstone fishes from Cromarty bearing Hugh Miller's autograph labels; several Wealden bones labelled by Dr. Mantell; a good representation of the English Lias; and a few examples of the Bristol Dolomitic Conglomerate with the remarkable Triassic reptilian bones.

The greater portion of Prof. Cope's collection at present occupies

the rooms of a private house, while many of the larger specimens are stowed away in the basement of one of the public museums. The lower room is the only one in which there is any attempt at display, such as would interest an ordinary visitor; but the apartments are fitted with shelves and drawers, where nearly all the specimens are placed in small boxes for convenient reference. When it is remembered that the large majority of the type-specimens described by the Professor are comprised in the collection, its richness will at once be understood; and the fossils are accompanied by a large number of recent zoological preparations, notably the Hyrtl Collection of fish-skeletons. In the exhibited series, the well-known skeleton of *Phenacodus*, the skulls of primitive Rhinoceroses, Camels, and other Mammalian bones are conspicuous; while the huge vertebræ and limbs of *Camarasaurus*, some Mosasaurian remains, etc., represent the Reptilia. The collection of Permian Amphibia, Reptilia, and Pisces from Texas, is unique; and the remarkable preservation of the skeletons in the red sandy matrix enables all the varied anatomical points made known by Prof. Cope to be clearly observed. The writer was especially interested in the skulls of the Ichthyotomous Elasmobranch "*Didymodus*," which certainly exhibit with distinctness the extraordinary fissuring of the chondro-cranium as described; though, in the strict sense of the term, is it scarcely accurate to name the segmented parts "bones"? *Ptyonodus* is also worthy of note as being founded upon teeth identical with those lately named *Hemictenodus* in Britain. The American Cretaceous collection is especially rich in Reptilia and Pisces, both from the adjoining State of New Jersey, and from the distant territories of the West. One small series of fossil fishes, from the Niobrara Beds of Dakota (described in Bull. U.S. Geol. Surv., vol. iv. No. 1), is contained in matrix identical in every respect with that of Sahel Alma, Mount Lebanon, and is of especial interest as comprising the same group of generic types as is now well known from the Asiatic locality. The Chimæroid teeth from the Greensand of New Jersey are also conspicuous, and would, in Britain, be nearly all referred to the genus *Edaphodon*. The North American collection is supplemented by a large series of (supposed) Cretaceous fish- and crocodilian-remains from Brazil, chiefly discovered by Mr. Joseph Mawson, F.G.S.; and among these may be noted a representative of the European and Asiatic Upper Cretaceous genus *Palæobalistum* (*Pycnodus flabellatus*, Cope), besides the well-preserved *Anædopogon tenuidens* from Ceara, which is identical with the fish bearing Agassiz' MS. name of *Cladocyclus Gardneri*. Among earlier Palæozoic fishes, the fine type-specimen of *Macropetalichthys* is also here, and much new information as to the characters of this remarkable shield will shortly be published by Professor Cope, who has lately been occupied in the study of the primitive group to which it is referred. Still more interesting, perhaps, is the type of the Carboniferous shielded organism, named *Mycterops*, which the Professor has naturally regarded as most difficult of interpretation, if truly one of the Chordata, as he originally supposed. The present

writer's somewhat extensive examination of Pteraspidian and other early Chordate types in Britain, Sweden, Russia, and Germany, has led him to the conclusion that *Mycterops* is certainly not related to any of these forms, but is truly an Eurypterid, with which the texture and superficial aspect of the specimen agree precisely. This determination, it may be added, is also adopted by Dr. R. H. Traquair, who informs the writer that he had already suspected some such affinity from a study of the published figure and description. Space prevents any adequate notice of the superb series of Tertiary Mammalian remains, of which the figures are now familiar to most palæontologists; and it is to be hoped that ere long these will be provided with the suitable mountings and cases that their delicate state of preservation demands.

(*To be concluded in our next Number.*)

III.—Note on the Denudation and Elevation of the Weald.

By Horace W. Monckton, F.G.S.,
of the Inner Temple.

It is, I think, practically admitted that the present condition of the Weald is the result, firstly of marine, and secondly of subaerial denudation. A plain of marine denudation was first formed, and the valleys were carved out by subaerial action.

As the Weald at present exists, we find the lower beds swelling up in the centre of the area from beneath the newer ones which lie around, and we also find that certain of these older beds are thickest in the centre, and gradually thin out towards the north, and probably also towards the south. The older beds in the centre are thus at a higher level above the sea than the newer ones around them. It has been suggested (Topley, Q.J.G.S. vol. xxx. p. 186) that the height of the lower beds in the centre may be due to the manner in which they were deposited, rather than to an excess of upheaval in the centre of the area; but this can scarcely be so, I think: for it seems hard to imagine a series of successive beds deposited most thickly one after another on the same spot, thus forming a high mound—the tendency of deposition being to fill up hollows, not to increase the height of hills.

If, however, we assume that the excess of deposition was the result of and coincided with an excess of depression, the matter becomes simple. Thus, from some undetermined period until the formation of the Gault, the south-east of England was an area of depression, and the progress of depression was more rapid upon the east and west line which now forms the anticlinal of the Weald than either to the north or to the south of it. If my readers will turn to Mr. Topley's diagrammatic section, plate vi. p. 242 of his memoir on the Weald, they will see that depression was more rapid under Crowborough Beacon than under London; and as deposition always attempts to fill up hollows, the rate of deposition was higher and the beds thicker in the former than in the latter locality. This was

clearly the case during the period from the beginning of the Purbeck to the end of the Lower Greensand.

Since that time a change in the earth movement of this area has taken place; for the line, which was then a line of excess of depression, has since become a line of excess of elevation forming the great anticlinal of the Weald; and it is clear that when the excess of depression on this line ceased, deposition would tend to become more uniform over the whole area; and when the line began to rise, deposition would be less over it than over the adjoining areas which were stationary or rising more slowly.

The great regularity in the thickness of the Gault on the north and south of the Weald leads me to suspect that the excess of depression of the central area ceased during the Gault period; and it is quite possible that if that area was beginning to rise during the Chalk and Tertiary periods, little or no Chalk or Tertiary beds were ever deposited there; and I look with suspicion on any estimate of the original height of the Wealden anticlinal founded on the assumed regularity of deposition over the whole area.

I thus reach the period when the elevation of the south-east of England began, and proceeded at a rate varying greatly in different places, thus forming the anticlinal of the Weald. At this point I am in conflict with the views of previous writers as to the formation of a plain of marine denudation. As I understand them, they contend that the plain was formed by the *advance* of the sea across the area "so as to shave it across." I doubt this. I believe the plain was formed during the *retreat* of the sea, that is to say, during the struggle of the land and water for mastery.

If I am right, the central portion of the area which was being elevated the more rapidly first reached the surface of the sea, and on reaching the surface was at once destroyed by the waves; but as time went on, and the area of elevation gradually extended, a larger and larger surface of the sea-bottom was brought in conflict with the waves, and it is not hard to picture to oneself the progress of the conflict and the final victory of the earth over the water. When the Wealden area, therefore, first rose above the sea, it presented, according to my theory, an extensive sandy flat; and as it emerged, subaerial denudation set in, which has gradually produced the present surface of the country.

In a well-known text-book the general effect of a partial submergence of the Weald is represented by a straight line parallel to sea-level; but, if I am correct, this is probably inaccurate: for if the area rises and falls at a rate varying in different parts, the effect of submergence would be represented by a curved line.

It is quite true that large areas may be elevated or depressed without losing their horizontality. According to Sir C. Lyell, the primary rocks remain horizontal over thousands of square leagues in America and Russia, in spite of great oscillations of level (Antiq. of Man, 1873, p. 396). But any given area must be judged by the evidence applicable to itself, and there is plenty of evidence that the South of England has been subject to differential earth movements

at various times. Thus the Chalk of the Hog's Back and Culver Cliffs was placed at its present angle by differential elevation during post-Bagshot times. The occurrence of Crag at Lenham seems to show that that portion of the country was submerged when the west was dry land. According to Prof. Prestwich, the old beach which is 8 to 12 feet above the sea at Brighton rises to 100 feet near Arundel, to 130 feet near Chichester, and to 140 feet at Bourne Common, and then falls to 125 feet above the sea at Portsdown Hill (Q.J.G.S. vol. xxviii. p. 38, Topley, Weald, p. 286); and if this is so, we have not only evidence of differential elevation, but of elevation in a curve instead of a straight line.

My conclusions are :—

1.—That during the deposition of the Wealden and Neocomian beds in the south-east of England, the area was one of depression, that the rate of depression of the centre was in excess of that of the surrounding area, thus causing the thickening of the beds towards the centre.

2.—That upon the area becoming one of elevation, the elevation was most rapid in the centre.

3.—That a large portion of the beds were removed by marine denudation as they rose out of the sea, a large sandy plain thus being formed; and that the plain of marine denudation spoken of by authors was not due to the advance of the sea over land.

Note.—Since this was written Prof. Prestwich's papers on the Westleton Beds have been published. He appears to attribute more of the denudation of the Wealden area to subaerial agencies than former authors.—H. W. M.

IV.—Tertiary and Post-tertiary Stratigraphy.

By Thos. R. Struthers.

Hon. Assoc. and late Vice-President, Geological Society of Glasgow.

As a basis for the following observations on the classification of Tertiary and Post-tertiary strata, we submit a comparative view of the nomenclature adopted by various authors.

	Lyell.	Dr. Hull.	Prof. Geikie.	J. B. Jukes.	Prof. Prestwich.
Post-tertiary.	1 Recent 2 Post-pliocene	1 Recent 2 Post-glacial	1 Recent 2 Post-glacial 3 Pleistocene	1 Recent 2, 3 Pleistocene	1 Recent 2, 3 Pleistocene
Tertiary	3 Newer Pliocene 4 Older Pliocene 5 Miocene 6 (Oligocene) 7 Eocene	3 Post-pliocene 4 Pliocene 5 Miocene 6 Oligocene 7 Eocene	4 Pliocene 5 Miocene 6 Oligocene 7 Eocene	4 Pliocene 5 Miocene 6 (Oligocene) 7 Eocene	4 Pliocene 5 Miocene 6 Oligocene 7 Eocene

Note.—*The segregation of the Oligocene from the Eocene had not been effected when Lyell and Jukes wrote.*

From the above table it will be noticed that Lyell and Hull assign the Glacial period—called by the former "Newer Pliocene," and by the latter "Post-pliocene"—to Tertiary or pre-human time; and the first appearance of Man in Europe to the period of

elevation which followed the submergence at the close of the Great Ice Age, when the climatic conditions and the adaptations of organic nature were becoming more and more favourable to the existence and welfare of the human species. This latter period is called by Sir Charles Lyell Post-pliocene, and by Dr. Hull Post-glacial. Professor Geikie, of the Edinburgh University, also uses the term Post-glacial for Lyell's Post-pliocene; and in his "Outlines of Geology" he expresses the opinion that "the palæolithic inhabitants of Europe settled in that continent during the Glacial period, and had disappeared before the advent of the Post-glacial and Recent period."

In his admirable "Manual of Geology," Mr. J. Beete Jukes, for convenience, embraces the Glacial and Post-glacial under one head —Pleistocene—a term originally employed by Lyell to indicate the Glacial period, but for which he substituted Newer Pliocene, because the late Professor Edward Forbes had used Pleistocene nearly in the same sense as that in which he (Lyell) uses Post-pliocene in his "Antiquity of Man" (Introduction, p. 6).

Dr. Hull adopts the term Post-pliocene instead of Lyell's Newer Pliocene to indicate the Glacial period, and in common with him places it in the *Tertiary* division of strata, while Professor Geikie and Mr. J. B. Jukes tabulate it as a *Post-tertiary* group under the designation of Pleistocene; the latter authority, in common with Professor Prestwich, including the Postpliocene under the same head.

We prefer to follow Jukes, Hull, and Geikie in discarding the term Post-pliocene; and instead of adopting Post-glacial as an equivalent, we propose to substitute Pleistocene. The terminology we suggest will be made plainer by reference to the following table:

Epochs.	Systems or Periods.	Groups and Sub-groups.
Quaternary or Neozoic.	Anthropozoic.	1. Holocene { Historic / Prehistoric (Neolithic). 2. Pleistocene, ,, (Palæolithic).
Tertiary or Cainozoic.	Megazoic.	3. Newer Pliocene (Glacial). 4. Older Pliocene. 5. Miocene. 6. Oligocene. 7. Eocene.

For the sake of phraseological sequence, we substitute the term Holocene (all recent) for the incongruous word Recent; and to supply the want of terms for the Tertiary and Post-tertiary *systems*, we distinguish the former as *Megazoic* (gigantic life) and the latter as *Anthropozoic* (human life), to indicate their leading zoological characteristics; and the substitution of Pleistocene for Post-pliocene or Post-glacial we consider an improvement upon the nomenclature verbally, without detriment to its descriptive applicability.

The term Post-glacial, as formerly designating a group, might be

objected to; for although there are now no glaciers in Britain, it cannot be doubted that on the reelevation after the general submergence of the ice-clad land at the close of the Newer Pliocene period, glaciers existed in the mountainous districts of Europe, including the British Islands, and had not entirely disappeared before the earliest human inhabitants arrived. From that time to the present glacial conditions have continued in elevated regions of both hemispheres, more especially in the circumpolar zones, whence myriads of icebergs are annually sent off to drop their burden of clay and boulders upon the bed of the ocean; while in Southern Europe, and even in lower latitudes, we have in the present day illustrations of phenomena due to movements of land-ice.

In human history the recognized median line between ancient and modern is the birth of Christ, and the generally accepted geological boundary between past and present is the advent of Man, an event which marks the commencement of a new epoch of the world's history, distinguished, in continuation of the ordinal classification of strata, as Quaternary, and, as on zoological grounds, Neozoic (new life); for certainly the presence of a rational being was something new and unprecedented; while at the same time the animal and vegetable kingdoms of the period consist of new species directly or indirectly adapted to the wants of the human race—cattle, and smaller quadrupeds fit for food or domestication; food fishes and food fowls, edible fruit, grain-bearing grasses, and herbage.

The term Post-tertiary is also employed to embrace the Neozoic groups, the newer being commonly called Recent, and the older Post-pliocene, terms for which we substitute Holocene and Pleistocene respectively. Some authors would group both Tertiary and Post-tertiary as Cainozoic—a designation under which the Tertiary strata alone are at present embraced; and which was originally adopted by Sir Charles Lyell to indicate the presence, in their groups, of mollusca specifically identical with those now living, their relative prevalence, in certain localities, being shown by the terms *Eocene* (a few recent); than *Miocene* (fewer), *Pliocene* (more); and its *Pleistocene* (most).

Adopting human life as the characteristic feature of the Post-tertiary epoch, we accept Lyell's term "Newer Pliocene" as descriptive of a Tertiary group embracing the lower, middle, and upper stages of the Glacial period, to which we may be justified in adding a fourth or drift stage; for the close of the Tertiary epoch appears to have been signalized by a widespread submergence of the ice-clad land by which its glacial cover was floated off, and carried away on ocean currents to drop its burden of clay and boulders at a distance from their parent source. It is more than probable that during the submergence not a few of the mountain summits of Britain remained above sea-level as islets shrouded in snow and ice, and beset with drifting floes which could not fail to imprint traces of their existence upon the ancient coast-line.

The record of the Newer Pliocene, or Glacial age, however, is involved in considerable obscurity, from the circumstance that both

in its earlier and later stages glacial conditions differing in intensity affected a considerable area of both hemispheres, a temperate period intervening. The method, compass, and force of the physical agents in operation during each of its stages form intricate subjects of investigation; and the extent to which the processes in the newer have overlapped, modified, or obliterated the geological features of the older, is not generally agreed on; but much may be learned on the subject of glacial agency from Dr. Archibald Geikie's "Scenery of Scotland," and Mr. Jukes-Browne's "Building of the British Isles," recent works of great merit.

The Quaternary epoch was inaugurated by a reelevation of land, which appears to have been effected by a series of sudden and intermittent movements; but a considerable period must have elapsed before Europe was prepared for the reception of its first human inhabitants; and this, so far as that Continent is concerned, may be regarded as a transition stage between Tertiary and Post-tertiary time; for the successive phases of organic and inorganic nature at all periods of the earth's geological history passed from one to the other, not suddenly and completely, but with the gradual change of climatic and other physical conditions, and the successive extinction of organisms characteristic of the older, and the gradual substitution of their successors in the newer order of things.

The close of the "drift" introduces us into what Lyell calls the Post-pliocene period, but which we denominate Pleistocene, when the existing terrestrial areas which had been submerged were developed and readjusted by repeated upheavals registered by a series of geological landmarks well known to science, every successive elevation increasing the extent of the low, fertile land, producing an important alteration of the coast-line, and relatively reducing the area under glacial conditions, which at last passed away, with certain exceptions, under the combined influence of the local and general physical causes by which climates are effected.

Although Man found his way into Europe long before it had attained its present development, when the climate was more ungenial, it may have been a considerable time after the elevatory movement began. This period of elevation, in the course of which Man made his appearance in Europe, as already stated, we denominate Pleistocene, as equivalent to Post-pliocene, and Post-glacial, and descriptive of the oldest group of the Anthropozoic system. This base line for the human period, however, must be understood as provisional, for geological authorities differ in opinion as to the particular stage of time which furnishes the earliest proofs of Man's presence, some insisting that he was a denizen of Europe during, or even before, the Great Ice Age; but the evidence in favour of this opinion is not so satisfactory as could be desired, and there is ample room for additional proof; so that in the meantime we may consider the question whether or not Man existed before, or during, the Glacial period as unsettled.

In the Pleistocene (Post-pliocene) period there were associated with Man in Europe certain species of Tertiary mammals now

extinct, while others of Neozoic origin, now living, coexisted with them; and this is not to be wondered at, for in the more ancient geological systems many genera and species ranged from the older to the newer, and were for a time contemporary with more recent forms of life. In the newer stage of the Post-tertiary epoch (*Holocene*) are classed the deposits in which *no extinct species* have been found. This group is divided into Historic and Pre-historic sub-groups; and to the latter belong the polished implements of Neolithic age, while the unpolished weapons belong to the older stage of Post-tertiary time (Pleistocene) known also as the Palæolithic or *ancient stone* period, to distinguish it from the Neolithic, or *new stone* period. The more recent of these periods, however, may be divided into an older and a newer stage, indicating an advance in culture, as illustrated by the relics found on the shores of the Danish islands.

V.—The Rocks of St. Davids.

By Henry Hicks, M.D., F.R.S., F.G.S.

IN a characteristic article by Prof. Blake, "On the Base of the Sedimentary Series in England and Wales," in the July Number of the Geological Magazine, amongst other erroneous statements, there is one which I must beg leave to correct. At page 310, in referring to the rocks of St. Davids, he makes the following statement: "While accepting the *later* petrological descriptions of Dr. Hicks, he (Dr. Geikie) minimized the separation between this [the Pebidian] and the Cambrian conglomerate, and challenged Dr. Hicks to prove his statement that the latter is chiefly composed of fragments of the rock on which it lies. This Dr. Hicks has never been able to do, seeing that the most marked feature of the conglomerate is that it is *not* composed of such fragments; instead of doing so, he now attempts to show that the matrix might have been derived from granitoid rocks."

One would never have supposed that any geologist who had made even a most imperfect examination of the district, and had but a slight acquaintance with the literature of the subject, would have ventured to make such a reckless assertion, especially after the published notes by such eminent petrologists as Prof. Bonney and Mr. Davies in the Q.J.G.S. vols. xl. and xlii., which give abundant examples to show that the Cambrian conglomerates contain fragments identical with the rocks underlying them. Moreover, at Ramsay Island, Trefgarn, and elsewhere, three-fourths of the pebbles in the conglomerate must have been derived from the rocks immediately below. In the Q.J.G.S. vol. xlii. p. 358, Prof. Bonney says, "The sections contain numerous fragments of felspar, very similar to that in the Dimetian; in short, they present every appearance of an 'arkose' to which granitoid rocks have largely contributed. Six out of the seven slides include well-marked fragments of granitoid rock. . . . . In all respects the section of this fragment curiously resembles the slides of 'Dimetian' rock." Again, at p. 362, he gives the following as his conclusions:—

"A. When the Chanter's Seat conglomerate was formed the following rocks were undergoing denudation:—
(1) Granitoid rocks, identical with the existing Dimetian.
(2) Trachytic rocks, among which were probably true lava-flows.
(3) Quartzites and schists, the latter resembling those which in many districts occur rather high in the Archæan series.
(4) Ordinary sedimentary rocks.
Hence there was in this district a series of rocks, some much older than others, which contributed to the formation of the Cambrian conglomerate.
B. The conglomerate above the Trefgarn series is formed from rocks which occur in the latter.
C. The peculiar characteristics distinctive of certain members of the Trefgarn series had been assumed by them when the conglomerate was formed.
D. Either the Dimetian is a member of an old gneissoid series or, if it is the core of a volcanic group from which the trachytic lavas had been ejected, this had been laid bare by denudation before the Cambrian conglomerate was formed. Hence in either case both the Dimetian and the felstones are Pre-Cambrian."

In the Q.J.G.S. vol. xl. Mr. T. Davies, in addition to describing numerous slides prepared from pebbles of felsites, quartz-felsites, basic volcanic rocks, porcellanites, etc., derived from the Cambrian Conglomerates and proved to be identical with the rocks of that character in the Pebidian series, makes the following statement, at p. 555, concerning the fragments of Dimetian in the conglomerate: "The view that the Cambrian conglomerate of St. Davids incloses much waterworn débris of the Dimetian is, I think, fully justified by the evidence now adduced from the examination of many slides of this rock, few of which have failed to afford evidence of the presence, not only of pebbles of a rock, which under the microscope could not be distinguished from it, but also of its individual mineral constituents. The slides examined and described here are not selected ones, but have been taken as they were cut. The peculiar quartz of the Dimetian, thronged as it is with extremely minute inclosures other than fluid, causing its well-known dirty aspect, is abundant. The felspars of both rocks are of the same character and habit, although necessarily more fragmentary in the conglomerate. Though not abundant, they are there, and can be most distinctly recognized. In some cases they are not more altered than in the Dimetian; but in others the structure has entirely disappeared, leaving a kaoline-like mass which feebly depolarizes light."

I may add that I am quite ready to submit the slides on which the above statements were founded, along with others since prepared, if possible containing still more conclusive evidence, to any unbiassed petrologist.

VI.—Note on certain Teeth referred to *Hyænodon indicus*.

By R. Lydekker, B.A., F.G.S., F.Z.S., etc.

In the "Palæontologia Indica," ser. 10, vol. ii. p. 349, fig. 21, I described and figured a lower premolar from the Siwaliks of the Punjab, under the name of *Hyænodon indicus*; the figure being reproduced in the accompanying woodcut (Fig. 1).

On the same and following pages I described two other teeth (figured in plate xliii. figs. 5, 6 of the same memoir), which were

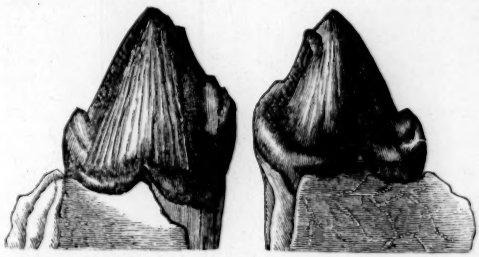

Fig. 1.—Fourth left [1] lower premolar of *Hyænodon indicus*. ½.

regarded as lower molars of a Carnivore. It was suggested that these teeth might belong to *Hyænodon indicus*, in which event that species would have to be transferred to another genus. Subsequently, in the "Cat. Foss. Mamm. Brit. Mus.," pt. 1, p. 32, fig. 2, I described and figured an imperfect tooth from the Quercy Phosphorites very similar to the problematical Indian teeth, and which was considered to indicate an allied form.

Fig. 2.—Inner and oral views of the imperfect right upper carnassial of *Amphicyon ambiguus*. ½.

Subsequent observations (for which I am indebted to a friend) have shown that I was totally mistaken in regard to the nature of these teeth. They are really imperfect upper carnassials of extinct Dogs, in which the inner tubercle has been broken away, and which I have figured the wrong way upwards. This will be apparent from Fig. 2, which is a reproduction of the figure of the Quercy tooth now turned the right way upwards. The Quercy specimen belongs to *Amphicyon ambiguus*, while the Indian teeth may be referred to *A. palæindicus*.

Finally, it may be well to mention that I see no reason to alter my opinion that the type of *Hyænodon indicus* (Fig. 1) indicates a Creodont either generically identical with or very closely allied to the Eocene species of *Hyænodon*.

VII.—Note on the Elevation of the Weald.

By the Rev. A. Irving, D.Sc. (Lond.), F.G.S.;
of Wellington College, Berks.

FEW students of Geology can doubt that the elevation of the Weald has been the most important factor concerned in determining the present surface-geology of the south-east of England. It has been constantly before my own mind in all my studies of Tertiary Geology for the last ten years, as the problem to the solution of which many other preliminary questions required

[1] In the original figure it is wrongly described as of the right side.

answers. In my first paper[1] on Tertiary Geology, read before the Geologists' Association in 1883, I pointed out that the presence of Eocene pebble-beds in the Woolwich and Reading series and in the Bagshot series afforded strong evidence of the encroachment of the sea upon the Upper Chalk in Eocene times. This conclusion is accepted by our greatest authority on Tertiary Geology, Prof. Prestwich.[2] The fact alone furnishes a strong presumption that the elevation of the Weald had commenced before the close of the Eocene period; while the many outliers of the Woolwich and Reading beds at high altitudes on the N. Downs, taken along with the general absence of the London Clay there, seems to tell us that the initial elevation of the Weald hill-range had gone far enough for this to form a shore to the area of deposition of the London Clay. I have shown further, in a former volume of the Geol. Mag.,[3] that, though there is no absolute proof, there are grounds for believing, that certain outliers of sands on the N. Downs (at Chipstead, Headley, and north of Netley Heath) are more likely to turn out to be of Upper Eocene age, than of any age to which they had been hitherto assigned by different writers. There is here the strong presumptive evidence of the lithological similarity to the Upper Bagshot, in most cases amounting almost to identity. In the Headley sections, as I saw them, there was just that difference in the beds being thinner than is usual in the Upper Bagshot, and at the same time the presence of a few scattered small unworn flints in the sands, which made me speak of them with more reserve; but which further consideration has suggested may be only just those differentiæ which may be explained by greater proximity to a shore, where the Chalk was undergoing destruction and furnishing the flints. On the other hand, there was on the surface what appeared to be the wreckage of a Bagshot pebble-bed at Headley, which suggests the Lower Bagshot as the more probable horizon for the sands at that place. Still these facts taken together do not of course militate against the view that the sands at the various localities mentioned may be of Upper Eocene (Bagshot) age.

To the minds of some the question as to age of these beds may appear to have been definitely settled, now that the Lenham deposits are shown to be of Diestian age, *i.e.* Older Pliocene.[4] This, of course, depends upon the contemporaneity of these deposits with the Lenham beds (some fifty miles further to the east) being established. This contemporaneity has been generally assumed on the ground of approximate equality of altitude above the sea; but this, after all, may be *a mere accident*, and if so any argument based on the assumption must give way; the chain cannot be stronger than than its weakest link. This assumption seems to be based on the further assumption that the elevation of the Weald has been

[1] On the Bagshot Beds of the London Basin and their associated Gravels, Proc. Geol. Assoc. vol. viii. pp. 143–171.

[2] Q J.G.S. vol. xlvi. pp. 116, 167.

[3] See Geol. Mag. Dec. III. Vol. V. (1888), pp. 183, 184.

[4] See Mr. Clement Reid's communication to *Nature* (1886), vol. xxxiv. pp. 341–2.

simultaneously commensurate throughout the whole distance from east to west; but I think it can be shown that there are fairly strong grounds for doubting this.

1. We have the record of at least two important lines of movement: (*a*) the Isle of Wight and Purbeck anticlinal; (*b*) the anticlinal axis of Kingsclere and Inkpen—the latter probably initiated at the age of the Upper Chalk as worked out by Dr. Barrois.[1] The former of these must have been initiated at about the beginning of the Oligocene period, in order to account for the relative lie and position of the Eocene and Oligocene strata of the island:[2] the latter (as I have previously pointed out elsewhere[3]) was, in all probability, somewhat advanced in later Eocene time.

Along each of the lines of movement the strata have been thrown into a position of much greater inclination on the north than on the south side. This seems to follow as a simple mechanical result of the resistance offered by the greater proximity of the great Mesozoic area (and perhaps the underground conformation of the Palæozoic rocks) of central Mercian England. Such movements could scarcely leave the western end of the Weald unaffected. These conditions fail when we attempt to apply them to the eastern part of the Weald. There are also such minor axes of elevation as those of Winchester and Portsdown, probably later Eocene.[4]

2. An examination of the stratigraphical structure of the Weald shows that the resultant displacement of the strata in the western part of the Weald is greater than that of the eastern part. This is well seen in the high angle of inclination of the chalk of the Hog's Back, and of the Neocomian strata of the Hindhead anticlinal.[5] It is reasonable to suppose that these recorded movements were initiated much earlier than those which have brought up the strata of the eastern part of the Weald to their present position; and this supposition is supported by the fact that the general axis of elevation of the Weald, which can be traced from its exposure in the cliffs east of Hastings, through Crowborough Beacon (the highest point in the Hastings Sands), Horsham, and Petersfield,[6] seems to be independent of, and posterior to, certain earlier movements which determined the initiatory stages of elevation of Hog's Back and Hindhead.

3. Mr. Topley,[7] has given us a table of *culminating points* of the chief formations of the Weald, showing, for each of the formations, the Chalk (both north and south), the Lower Greensand, and the Hastings Beds—"a general fall of the summits" from west to east; a result scarcely to be accounted for by greater denudation towards the east, but probably connected with the greater disturbance to which the western part of the Weald has been subjected. It is in

[1] See "Récherches sur le Terrain Cretacé superieur," figures 4 and 8 on the plate at the end; also p. 113.

[2] See (*e.g.*) the section (No. 3) of Ramsay's Geological Map of England and Wales.

[3] Q.J.G.S. vol. xliv. p. 181.

[4] Barrois, *op. cit.* p. 115.

[5] See Topley, "Geology of the Weald," p. 232.

[6] Topley, *ibid.*

[7] *Ibid*, pp. 240, 241.

the western part of the Weald too (*e.g.* at Leith Hill and near Farnham) that the same authority [1] tells us that the greatest amount of dislocation occurs; the faults recorded at these two localities being apparently connected with the Hog's Back line of elevation, as is also another south of St. Martha's, near Guildford.

4. The chief *transverse synclinals* of the Weald are those of the valleys of the Medway and the Stour on the north-east side, and of the Adur and the Arun on the south side; while there appears to be an absence of such synclinals on the north side of the western part of the Weald.[2] This looks very much as if they were formed in a series of later movements caused by forces acting from the south-east or east, and not affecting the previously-elevated portions of the Weald to the north-west.

5. The fact that the raised beaches rise as they are traced west, till at Bourne Common, near Goodwood, they are 130 feet higher than at Brighton,[3] has been pointed out by Mr. Topley as showing greater western elevation.

A progressive elevation of the English portion of the Weald from west to east, such as the facts advanced above would seem to indicate, leads of necessity to the conclusion that the assumption (which has so often been made in certain quarters) that the mere accident of the Lenham deposits being now at almost the same elevation as certain outliers at Chipstead, Headley, and on the north side of Netley Heath, points to their contemporaneous age, is scarcely tenable. For, if such an elevation went on progressively in the direction indicated, it may well have happened that those outliers of sands may represent transgressive portions of the later Eocene, and have been raised above sea-level during Miocene or early Pliocene times, while the north-eastern portion of what is now the Weald was still beneath the waters of the Pliocene sea, and receiving deposits, of which remains are preserved to us in the hollows of the Chalk at Lenham. The general strike of the strata from the valley of the Medway to Folkestone seems to favour this view.

A little reflection will show that the same negative reasoning applies to the rather characterless plateau-gravel described by Prof. Prestwich [4] as occurring on the hills west of Canterbury. There is nothing in the nature of things to necessitate contemporaneity, though similar causes acting under similar conditions have produced similar results; on the other hand, there are, as we have seen, facts which militate against the assumption of contemporaneity of similar deposits situate so far as these are from those of East Berks and West Surrey, notwithstanding the fact that they are all of pre-Quaternary age.

But I think there is not wanting evidence of a more general nature, tending to show that the Wealden area must have made some advance towards the position of a hill-range before the close of the Eocene period. This evidence is found in (i) the high inclination of the Lower Eocene strata along the northern flank, as seen at Highclere; (ii) the shallowing of the waters of the

[1] *Ibid*, pp. 230, 232, 233.
[2] Topley, *Ibid*, pp. 277, 278.
[3] *Ibid*, p. 286.
[4] Q.J.G.S. vol. xlvi. p. 156; see also pl. viii.

Anglo-Gallic sea and deposition of the Oligocene strata, with which the Tertiary record closes in the Paris and Hampshire Basins; (iii) the absence of marine deposits of Miocene age; (iv) the great palæontological break between the Oligocene and the Crag, "not a single species in any class being common to these two series in Britain."[1] Further reflection during recent years upon the significant fact, that we have no trace of Miocene marine deposits in the South-East of England, has led me to the conclusion that the Wealden and Tamisian areas were "dry land," and therefore undergoing subaërial waste and degradation all through that period of geologic time and on into the Pliocene, as, in fact, Prof. Zittel has represented matters in his Map of Middle Europe in Miocene times.[2] Mr. Etheridge appears to have arrived at the same conclusion, as he has remarked (*op. cit.* p. 651), "Britain, so far as we know, was a land-surface forming part of the continent during part of the Miocene period." We may therefore hesitate to follow Professor Prestwich in dating the great elevation of the Weald posterior to the Miocene.[3] The commencement of this elevation is referred by Zittel (*op. cit.* p. 433) to the Oligocene period, a simultaneous depression of North Germany occurring, so that the waters of the North Sea overflowed that region as far south as Bonn, and washed the flanks of the Hartz and Thuringian mountains. Credner[4] gives a more detailed description of this, and tells us that this depression continued on a more restricted scale during the Miocene, the Tertiary deposits of North Germany being exclusively of Oligocene and Miocene age, the Oligocene strata of that region being partly marine, partly terrestrial, the latter yielding the chief supply of brown-coal. At various points in North-western Germany — Schleswig, Holstein, Lauenburg, West Mecklenburg, Northern Hanover—Miocene strata are recognized; and they appear to stretch away to the south-west through Oldenburg and Westphalia to Hasselt and Antwerp, being recognized by Von Koenen as contemporaneous deposits, differing only in their physical facies from those of his Diestian and Bolderian system.[5] This Miocene and early Pliocene basin may represent the area of depression on the north side of the region of Miocene elevation (which included the present regions of the Weald, the English Channel in its eastern portion, and the north of France), and seems to have corresponded with a similar depression of the Loire basin, where the Tertiary record commences with the Miocene. These alterations of level were some of the minor incidents of those great changes of contour of Central and Western Europe, which are recorded in the Alps and Carpathians, and perhaps most markedly in the Pyrenees (where the Nummulitic Limestone is lifted up to the crests of mountains more than 10,000

[1] Etheridge, "Manual of Geology," p. 652.

[2] "Aus der Urzeit" (Oldenbourg, Munich), p. 459.

[3] See also Ramsay, "Phys. Geol. and Geog. of Great Britain" (5th ed.), pp. 274, 356.

[4] "Elemente der Geologie" (6th ed.), pp. 695–703.

[5] Credner, *op. cit.* p. 714. If we follow Mr. C. Reid in relegating the Diestian to the older Pliocene, these North German deposits may be of Pliocene age also; but this is a detail which does not much affect the general argument.

feet above the sea, while the Miocene strata lie horizontally against the highly inclined older strata on the north side),[1] changes which effectually mark off the Older from the Younger Tertiaries of Europe.

A gradual subsidence during Pliocene time of the Tamisian area would admit of the extension of the northern waters again to the west, so as to cover a portion of the East Anglian area, and give us the Crag deposits in a shallow sea bounded on the west and south by a zone of older Tertiaries, across which there must have been extensive transport of detritus from the elevated Cretaceous regions of East Mercian England on the north-western side, and the Weald on the southern side. These seem to me to have been approximately the physiographic condition under which the plateau-gravels north of the Thames were accumulated. And if this were so, there is no real necessity for associating the Westleton Shingle of Prestwich with the plateau-gravels on the south of the Thames; for the flint pebbles and fragments of the former were in all probability derived from the Chalk of Norfolk and Suffolk.[2] The list of organic remains of the Westleton and Mundesley Beds, given by Prof. Prestwich in Part I. of his recent paper, shows such a preponderance of land- and fresh-water-remains as to suggest an estuarine origin for these beds; so that we might not be very far wrong if we regarded them as accumulated at the beginning of the Quaternary period near the western margin of the older Rhine estuary, which received the drainage of the East Anglian and lower Tamisian areas.

The admission that the inland representatives of the Westleton and Mundesley shingle-beds may be of terrestrial origin, similar to that which is assigned to the plateau-gravels on the south side of the Thames, would remove two difficulties, which must, I think, have presented themselves to the minds of others besides myself:—(1) It is difficult to accept the view of such a wide-spread marine floor at about the beginning of the Quaternary period, as would extend the waters of the German Ocean to the flanks of the Cotswolds, with a subsequent elevation towards the west of some 500 feet, unless independent and collateral evidence of a less equivocal nature can be adduced in support of the hypothesis. (2) There is a great difficulty in explaining the unfossiliferous character of those inland gravels, on the theory of 'decalcification'; since so many of them are covered (as shown in Prof. Prestwich's sections[4]) by Boulder-clay, which must have served as an impervious protection to them from the action of atmospheric carbonated waters. It is somewhat curious that this theory of decalcification has been applied where it will not very well work, but not to the plateau-gravels of the Southern Drift, where the same difficulty does not arise.

The recognition of the Pliocene age of those inland gravels and sands, and of their terrestrial origin, would give us also a wide limit of time for the formation of the East Mercian Chalk Escarpment, and of the present valley-system, and so remove a still further difficulty.

[1] Credner, *op. cit.* p. 722.

[2] The inference fairly to be drawn from the absence of Tertiary deposits in the Midland and Northern Counties is in accordance with this view.

[3] See Q.J.G.S. vol. xlvi. pp. 115-117.

[4] Q.J.G.S. *loc. cit.*

A Miocene elevation of the Weald and of East Mercian England, such as has been here suggested, would allow that longer period of time for the subaërial waste of the Chalk, which is required to account for the angular flint fragments of the plateau-gravels, especially as we see them on the hills above Aldershot, where the materials have not been transported very far. On the Chalk Downs above Ventnor we see them still in position, just as they are left by the solution of a chalk matrix with very little argillaceous material. It seems probable that the materials thus furnished may have acquired the subangular form which they exhibit in the plateau-gravels of the Southern Drift during their transport northwards in Pliocene times, owing perhaps to accentuation of the anticline of the Weald at that period, and its elevation into a more definite hill-range, causing an increase of precipitation and a greater volume and rapidity of flow, with a correspondingly greater transporting power, of the rivers which flowed from it, to convey the flinty materials of the plateau-gravels, along with the débris of Neocomian rocks.

These are little more than suggestions, but perhaps worthy of consideration. I do not think they have been sufficiently considered in connection with the general problem; and this may be a justification for the appearance of this short paper.

VIII.—On Some Small Bivalve Shells from the Karoo Formation, South Africa.

By Professor T. Rupert Jones, F.R.S., F.G.S., etc.

Amongst the specimens sent many years ago, from South Africa, by the late Mr. Andrew Geddes Bain, to the Geological Society of London, are two small blocks of greenish-grey hard mudstone or shale, very slightly calcareous; one bed-plane in each specimen bears upon its surface numerous valves of one or more forms of small Lamellibranchs, closely resembling the shells of the genera *Cyrena* and *Cyclas* in contour.

The longest axis of one of the largest and best-preserved individuals is 7 millimètres, the shorter 5 mm. A smaller, well-shaped form measures 5 mm. by 4·5 mm. Only in a few instances has it been found possible to develope these little valves from their matrix, so as to show their contours clearly and accurately.

Within certain limits, these little shells vary much in size and contour, as the following measurements numerically express in mm.:

From the anterior to the posterior margin of valve.		From the umbo to the ventral margin of valve.
3	×	$2\frac{1}{2}$
$3\frac{1}{2}$	×	$2\frac{1}{2}$
$4\frac{1}{2}$	×	3
5	×	$4\frac{1}{2}$
5	×	5
6	×	4
6	×	5
7	×	4
7	×	5
7	×	$5\frac{1}{2}$
8	×	5 (lengthened by crush).

The specimens are brown casts, having the surface concentrically wrinkled, with lines of growth rather numerous, sometimes strong, and often irregular, apparently from pressure on a thin shell. This, if once calcareous, has disappeared, leaving a brown film externally, and a thin dark line, where it has been broken across, in the stone. They remind us, in general appearance, of similar shells in the English Wealden.

The shape varies from suborbicular to oval, suboval, and trigonal; some have evidently been shortened and others lengthened by pressure. One specimen has obscure remnants of a hinge, showing traces of cardinal and lateral teeth.

It occurs to me that these small Bivalves may be conveniently referred to *Cycladidæ*, and probably more nearly allied to *Cyrena* than to *Cyclas*. Hence we may provisionally name them *Cyrena? neglecta*.

These two little blocks of Karoo stone were collected by Mr. Bain at the village of Balfour, on the right bank of the Kat River, 400 yards north of the Rev. Mr. Thompson's house, and are preserved in the Museum of the Geological Society, London.

A portion of one of the blocks from the Kat River, Eastern Province, South Africa, showing four of the small shells and parts and sections of others; magnified twice the natural size.

These differ from the four South-African "*Cyrenæ*" (?) figured and described or noticed by D. Sharpe in the Trans. Geol. Soc. ser. 2, vol. vii. pp. 199, 202, and 225, pl. 28, figs. 7, 8, 9, and 13. Fig. 7 (undetermined) is from the same great Karoo formation, further north, at Graaf Reinet; but figs. 8 and 9 (undetermined), and 13 (*Cyrena? Bainii*) are from a different series of strata on the Zwartkop River.

IX.—Fossil Types in the Bristol Museum.

By E. Wilson, F.G.S.;
Curator of the Bristol Museum.

(*Concluded from the August Number, page* 372.)

Pelecypoda—*continued.*

Lucina pisum, J. de C. Sowerby (non d'Orbigny) (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 341, pl. xvi. f. 14; F. Stoliczka, Cret. Pel. of S. India, p. 252 [valves united]. Up. Greensand, Blackdown.

Macrodon? rapidus, G. F. Whidborne, Q.J.G.S. vol. xxxix. p. 521, pl. xviii. f. 3 (in part type) [right valve]. Inf. Ool. Dundry.

Macrodon rasilis, G. F. Whidborne, Q.J.G.S. vol. xxxix. p. 521, pl. xvi. fs. 15, 15*a*, 15*b* [right valve]. Inf. Ool. Bradford Abbas.

Mactra? angulata, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 341, pl. xvi. f. 9; F. Stoliczka, Cret. Pel. of S. India, p. 55 [valves united]. Up. Greensand, Blackdown.

Modiola reversa, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 342, pl. xvii. f. 13; F. Stoliczka, Cret. Pel. of S. India, p. 373 [right valve]. Up. Greensand, Blackdown.

Modiolopsis acutiprora, W. J. Sollas, Q.J.G.S. vol. xxxv. p. 426, pl. xxiv. fs. 21, 22 [left valve, 2 casts and 1 mould in gutta-percha]. Wenlock, Rhymney Quarry, Cardiff.

Mya læviuscula, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 340, pl. xvi. f. 6 [right valve]. Up. Greensand, Blackdown.

Myoconcha unguis, G. F. Whidborne, Q.J.G.S. vol. xxxix. p. 530, pl. xviii. f. 21 [left valve]. Inf. Ool. Dundry.

Mytilus inæquivalvis, J de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 342, pl. xvii. f. 16; syn. of *M. lanceolatus*, Sow. Min. Conch. pl. 439, f. 2; F. Stoliczka, Cret. Pel. of S. India, p. 372. Up. Greensand, Blackdown.

Mytilus prælongus, J. de C. Sowerby (Fitton), Trans. Geol. Soc ser. ii. vol. iv. p. 342, pl. xvii. f. 15; syn. of *M. lanceolatus*, Sow., d'Orbigny, Terr. Cret. vol. iii. p. 270; F. Stoliczka, Cret. Pel. of S. India, p. 372 [left valve]. Up. Greensand, Blackdown.

Mytilus striatissimus, G. F. Whidborne, Q.J.G.S. vol. xxxix. p. 519, pl. xvi. f. 12 [right valve]. Inf. Ool. Dundry.

Mytilus tridens, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 342, pl. xvii. f. 14; syn. of *M. lanceolatus*, Sow., d'Orbigny, Terr. Cret. vol. iii. p. 270; F. Stoliczka, Cret. Pel. of India, p. 372 [double valve and left valve]. Up. Greensand, Blackdown.

Nucula lineata, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 342, pl. xvii. f. 9; *Nuculina*, F. Stoliczka, Cret. Pel. of S. India, p. 326; *Leda*, W. Downes, Q.J.G.S. vol. xxxviii. p. 88; J. S. Gardner, Q.J.G.S. vol. xl. p. 136 [double shell and left valve]. Up. Greensand, Blackdown.

Nucula nuciformis, G. F. Whidborne, Q.J.G.S. vol. xxxix. p. 525, pl. xviii. fs. 5, 5*a* [valves united]. Inf. Ool. Dundry.

Nucula obtusa, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 342, pl. xvii. f. 11; F. Stoliczka, Cret. Pel. of S. India, p. 326; J. S. Gardner, Q.J.G.S. vol. xl. p. 126 [left valve]. Up. Greensand, Blackdown.

Orthonota navicula, W. J. Sollas, Q.J.G.S. vol. xxxv. p. 496, pl. xxiv. f. 3 [valves united]. Up. Ludlow, Cross Dowton, Rhymney.

Panopæa ovalis, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 340, pl. xvi. f. 5; *Myacites*, J. Morris, Cat. Brit. Foss. 2nd ed. p. 214; *Panopæa*, F. Stoliczka, Cret. Pel. of S. India, p. 87 [valves united]. Upper Greensand, Blackdown.

Pecten barbatus, J. Sowerby, Min. Conch. pl. 231 [natural mould]. Inf. Ool. Dundry.

Pecten compositus, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 342, pl. xvii. f. 20; F. Stoliczka, Cret. Pel. of S. India, p. 428 [single valve]. Up. Greensand, Blackdown.

Pecten Millerii, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 342, pl. xvii. f. 19; F. Stoliczka, Cret. Pel. of S. India, p. 428 [left valve]. Up. Greensand, Blackdown.

Pecten Stutchburianus, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 342, pl. xviii. f. 1; F. Stoliczka, Cret. Pel. of S. India, p. 428 [imperfect shell]. Upper Greensand, Blackdown.

Petricola? canaliculata, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 341, pl. xvi. f. 10; *Acanthocardium* (*Cardium*), F. Stoliczka, Cret. Pel. of S. India, pp. 141, 213 [right valve]. Up. Greensand, Blackdown.

Pholadomya spatiosa, G. F. Whidborne, Q.J.G.S. vol. xxxix. p. 534, pl. xix. f. 11 [valves united]. Inf. Ool. Dundry.

Thracia leguminosa, G. F. Whidborne, Q.J.G.S. vol. xxxix. p. 531, pl. xviii. fs. 23, 23*a* [valves united]. Inf. Ool. Dundry.

Trigonia quadrata, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 342, pl. xvii. f. 12; syn. of *Trigonia dædalea*, Parkinson, J. Lycett, Brit. Foss. Trigoniæ, Pal. Soc. p. 100 [right and left valves]. Up. Greensand, Blackdown.

Venus immersa, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 342, pl. xvii. f. 6; ? *Cyprimeria* or *Cytherea*, F. Stoliczka, Cret. Pel. of S. India, p. 161 [valves united]. Up. Greensand, Blackdown.

Venus sublævis, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 342, pl. xvii. f. 5; *Cytherea*, F. Stoliczka, Cret. Pel. of S. India, p. 161 [left valve]. Upper Greensand, Blackdown.

Venus? truncata, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 341, pl. xvii. f. 3; *Cytherea*, J. Morris, Cat. Brit. Foss. 2nd ed. p. 201; *Caryatis*, F. Stoliczka, Cret. Pel. of S. India, p. 161. Upper Greensand, Blackdown.

Brachiopoda.

Rhynchonella Dundriensis, S. S. Buckman, Proc. Dorset Nat. Hist. Club, vol. iv. p. 43 (1882); *Rhynchonella*, sp. T. Davidson, Brit. Foss. Brach. Pal. Soc. vol. i. Appendix, pl. A. f. 28; *Rh. Dundriensis*, Buckman, T. Davidson, Appendix to Supplement Brit. Foss. Brach. vol. v. p. 272, pl. xix. f. 10 [valves united]. Inf. Ool. Dundry.

Terebratula Etheridgii, T. Davidson, Brit. Foss. Brach. Pal. Soc. vol. i. Appendix, p. xx. pl. A. fs. 7, 8 [valves united]. Inf. Ool. Dundry.

Terebratula? megatrema?, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 343, pl. xviii. f. 3; *Argiope*, T. Davidson, Brit. Foss. Brach. Pal. Soc. vol. i. Cret. Brach. p. 101, pl. xii. f. 31? (non f. 32), [valves united, valves gaping]. Upper Greensand, Warminster.

Note.—There is some doubt as to this being the type. The specimen in the Bristol Museum so referred is stated to have come from "Warminster," but Sowerby gives "Blackdown" as the locality of his type. The specimen in this Museum agrees very well with Sowerby's figure, and also with Davidson's reproduction of the same (fig. 31, supra), but not with fig. 32, the specimen stated by him to be in the Bristol Museum.

Terebratula punctata, var. *Radstockensis*, T. Davidson, Supplement to Brit. Jur. and Trias. Brach. Pal. Soc. vol. iv. p. 131, pl. xvi. f. 14 (pars.) [valves united]. M. Lias, Radstock.

Crustacea.

Tropifer lævis, C. Gould, Q.J.G.S. vol. xiii. p. 360, woodcut, fs. 1, 2, 3; H. Woodward, Cat. Brit. Foss Crust. B. M. p. 16 [carapace, 4 abdominal segments and fragment of limb]. Rhætic (bone-bed), Aust Cliff.

Note.—This interesting little crustacean is imbedded in a coprolite and must therefore have served as the food of some fish of the Rhætic period.

Annelida.

Serpula filiformis, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 340, pl. xvi. f. 12. Up. Greensand, Blackdown.

Serpula tuba, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 340, pl. xvi. f. 3. Up. Greensand, Blackdown.

Serpula vermes, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 340, pl. xvi. f. 4. Up. Greensand, Blackdown.

Crinoidea.

Pentacrinus Millerii, T. and T. Austin, Mono. Crinoidea, p. 120, pl. xvi. f. 1*a*; syn. *P. scalaris*, Goldfuss [branching arms]. Gt. Ool. Lansdown, near Bath.

Periechocrinus? *articulosus*, T. and T. Austin, Ann. Mag. Nat. Hist. vol. xi. (1843), p. 204 (probably the type) [calyx]. Wenlock. Dudley.

Periechocrinus? *globosus*, T. and T. Austin, Ann. Mag. Nat. Hist. vol. xi. (1843), p. 204 (? the type) [portion of calyx]. Up. Silurian. Glyddon Hill.

Platycrinus anthelionites, T. and T. Austin, Ann. Mag. Nat. Hist. vol. xi. (1843), p. 199. Mono. Crinoidea, p. 27, pl. ii. f. 3*m*; syn. of *Pl. pileatus*, Goldfuss; Morris; Cat. second ed. p. 87 [calyx]. Carb. Limest. ? Loc.

Actinozoa.

Montlivaltia Stutchburyi, M. Edwards and J. Haime, Brit. Foss. Corals, Pal. Soc. p. 131, pl. xxvii. f. 3. Inf. Ool. Nunney, near Frome.

Plantæ.

Megaphyton elongatum, R. Kidston, Trans. Roy. Soc. Edinburgh, vol. xxxiii. pt. 2, p. 390, pl. xxvi. f. 1. Coal Measures, Radstock ?

Described and Figured Fossils (other than Type Specimens) in the Bristol Museum.

Mammalia.

Canis lupus, Linnæus, "Wolf" and "Small Wolf," J. Cottle, The Oreston Caves, folio ed. pl. v. f. 8; pl. iii. fs. 3, 4; pl. iv. f. 4 [portions of upper jaw with four molar teeth, humerus, ulna, os calcis and astragalus]. Pleist. (Cave-earth), Oreston Caves, Plymouth.

Canis vulpes, Linnæus, "Fox," J. Cottle, The Oreston Caves, folio ed. pl. iv. f. 5 [fragmentary ulna]. Pleist. (Cave-earth), Oreston Caves, Plymouth.

Elephas (*Euelephas*) *antiquus*, H. Falconer, Q.J.G.S. vol. xiii. p. 319; Palæont. Memoirs of Hugh Falconer, vol. ii. p. 179 (not figured) [2nd with molar, left side lower jaw]. Pleist. (cave earth), Durdham Down Cave, near Bristol.

Equus caballus, Linnæus, "Horse," J. Cottle, The Oreston Caves, folio edition, pl. ii. f. 1 [fragment of lower jaw with three incisor teeth]. Pleist. (Cave-earth), Oreston Caves, Plymouth.

Felis leo, Linnæus = *F. spelæa*, Goldfuss, "Tiger," J. Cottle, The Oreston Caves, folio ed. pl. i. f. 6, and pl. iii. f. 1. [fragment of upper jaw with 4th præ-molar and humerus]. Pleist. (Cave-earth), Oreston Caves, Plymouth.

Rhinoceros hemitœchus, H. Falconer, Palæont. Mem. of Hugh Falconer, vol. ii. p. 349 (not figured); syn. of *Rh. leptorhinus*, Owen; R. Lydekker, Cat. Foss. Mam. B.M. pt. ii. p. 101 [worn upper molar teeth, viz. 2nd and 3rd molars, and left antepenult. and penult. true molars, and two premolars in pairs]. Pleist. (Cave-earth), Durdham Down Cave, near Bristol.

Sus scrofa, Linnæus, "Hog," W. Buckland, Reliq. Diluv. pp. 57-59, pl. xi. fs. 30-33 [molar teeth and canine tooth of upper jaw]. In the "Catcott Cabinet," formerly deposited in the Bristol City Library and now in the Bristol Museum. Pleist. (Cave-earth), Hutton Cave, Mendip Hills.

Pisces.

Cladodus conicus? L. Agassiz, Poiss. Foss. vol. iii. p. 199 (not figured), [tooth in matrix divided longitudinally]. Millstone Grit, ? Honeypen Quarry, Bristol.

Note.—Possibly this is the imperfectly-preserved specimen referred probably to this species by Agassiz.

Cladodus Milleri, L. Agassiz = *Cl. mirabilis*, Agass., J. W. Davis, Scient. Trans. Roy. Dublin Soc. vol. i. ser. ii. p. 378, pl. xlix. f. 16 [tooth in matrix shown in longit. section]. Carb. Limest. (black rock), ? Avon Gorge, Clifton.

Ctenacanthus tenuistriatus, L. Agassiz, J. W. Davis, Scient. Trans. Roy. Dublin Soc. vol. i. ser. ii. p. 335, pl. xliii. fs. 2, 2*a*, 2*b*; syn of *Ct. major*, Agass., A. S. Woodward and C. D. Sherborn, Brit. Foss. Vert. p. 49 [dorsal spine]. Carb. Limest. (black rock), Avon Gorge, Clifton.

Orodus cinctus, L. Agassiz, J. W. Davis, Scient. Trans. Roy. Dublin Soc. vol. i. ser. ii. p. 392, pl. l. f. 8 [a series of 4 teeth]. L. Limest. Shales (bone bed) Avon Gorge, Clifton.

Orodus ramosus, L. Agassiz, J. W. Davis, Scient. Trans. Roy. Dublin Soc. vol. i. ser. ii. p. 390, pl. l. fs. 1, 2, 5*a*, *b* [series of 3 teeth and single tooth]. Carb. Limest. (black rock), Avon Gorge, Clifton.

Psammodus rugosus, L. Agassiz, J. W. Davis, Scient. Trans. Roy. Dublin Soc. vol. i. ser. ii. p. 459, pl. lvi. f. 6 and pl. lvii. f. 1 [teeth]. Carb. Limest., Armagh and Clifton.

Note.—Plate lvi. f. 6 represents a triangular tooth from Armagh, pl. lvii. f. 1 a group of 3 or 4 teeth from the black rock of the Avon Gorge, Clifton.

Tomodus convexus, L. Agassiz, MS., J. W. Davis, Scient. Trans. Roy. Dublin Soc. vol. i. ser. ii. p. 446, pl. lv. fs. 16, 18 [2 teeth]. Carb. Limest. (black rock), Avon Gorge, Clifton.

Cephalopoda.

Belemnites tubularis, Young and Bird, J. Phillips, British Belemnitidæ, Pal. Soc. p. 68, pl. xiv. f. 36, B. U. Lias, Loc. doubtful.

Note.—This specimen is said to be from near Gloucester, but there is little reason to doubt that it is a Yorkshire specimen from the neighbourhood of Whitby, vide Phillips, loc. cit.

Gasteropoda.

Alaria (*Pterocera*) *Lorieri*, A. d'Orbigny, *var. A.*, W. H. Hudleston, Pal. Soc. Inf. Ool. Gast. pt. i. p. 133, pl. vi. f. 6*d*. Inf. Ool. Dundry.

Alaria Lotharingica, Schlumberger, E. B. Tawney, Proc. Bristol Nat. Soc. N.S. vol. i. p. 22; W. H. Hudleston, Pal. Soc. Inf. Ool. Gast. pt. i. p. 125, pl. v. f. 9, Inf. Ool. Dundry.

Amberleya (*Eucyclus*) *goniata*, E. Deslongchamps, E. B. Tawney, Proc. Brist. Nat. Soc. N.S. vol. i. p. 28, pl. ii. f. 5. Inf. Ool. Dundry.

Amberleya (*Turbo*) "*ornata*," J. Sowerby, E. B. Tawney, Proc. Brist. Nat. Soc. N.S. vol. i. p. 27, pl. i. f. 9; "syn. of *Amberleya* (*Turbo*) *capitanea*, Münster." Inf. Ool. Dundry.

Dentalium medium, J. Sowerby, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 343, pl. xviii. f. 4. Up. Greensand, Blackdown.

Euspira (*Natica*) *Bajocensis*, A. d'Orbigny, E. B. Tawney, Proc. Brist. Nat. Soc. N.S. vol. i. p 13, pl. i. fs. 2, 4. Inf. Ool. Dundry.

Euspira (*Natica*) *Zelima* ?, A. d'Orbigny, E. B. Tawney, Proc. Brist. Nat. Soc. N.S. vol. i. p. 14, pl. i. f. i. Inf. Ool. Dundry.

Pleurotomaria subreticulata, A. d'Orbigny, E. B. Tawney, Proc. Brist. Nat. Soc. N.S. vol. i. p. 46, pl. iii. f. 7. Inf. Ool. Dundry.

Purpurina Bellona, A. d'Orbigny, E. B. Tawney, Proc. Brist. Nat. Soc. N.S. vol. i. p. 11, pl. iii. f. 8. Inf. Ool. Dundry.

Rostellaria Parkinsoni, J. Sowerby, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 344, pl. xvii. f. 24; *Alaria*, F. Stoliczka, Cret. Gast. of S. India, p. 30. Up. Greensand, Blackdown.

Trochus Zetes, A. d'Orbigny, E. B. Tawney, Proc. Brist. Nat. Soc. N.S. vol. i. p. 32, pl. ii. f. 7. Inf. Ool. Dundry.

Pelecypoda.

Astarte sufflata, F. Römer, G. F. Whidborne, Q.J.G.S. vol. xxxix. p. 527, pl. xviii. fs. 15, 16 [double shell and left valve]. Inf. Ool. Dundry.

Cardinia concinna, J. Sowerby, S. Stutchbury, Ann. Mag. Nat. Hist. vol. viii. (1842) p. 485, pl. x. f. 13 [left valve with fragment of right valve]. L. Lias, Langar, Notts.

Cardinia Listeri, J. Sowerby, J. Stutchbury, Ann. Mag. Nat. Hist. vol. viii. (1842), p. 482, pl. ix. fs. 1, 2 [double shell and right valve]. L. Lias, Hewletts Hill, Cheltenham.

Lima semisulcata, Nilsson, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 336, pl. xii. f. 10 [single valve ? left]. Up. Greensand, Blackdown.

Trigonia alæformis, J. Sowerby, Min. Conch. pl. 215, f. 3; syn. of *T. aliformis*, J. Parkinson, Organic Remains vol. iii. p. 176. Up. Greensand, Blackdown.

Brachiopoda.

Productus comoides, J. Sowerby; *Chonetes*, T. Davidson, Q.J.G.S. vol. x. p. 202, pl. viii. f. 1, and Brit. Foss. Brach. vol. ii. p. 180, pl. xlv. f. 7 [double shell]. Carb. Limest. Loc. doubtful.

Waldheimia ? (*Terebratula*) *Anglica*, A. Oppel, T. Davidson, Brit. Foss. Brach. Supplement to vol. i. p. 20, pl. A. fs. 10? 11-13, as var. of *T. sphæroidalis*, Sow.; *op. cit.* Supplement to vol. iv. p. 135, as *T. Anglica*, Oppel; *op. cit.* vol. v. p. 270, as *Waldheimia* [3 or 4 double shells as casts]. Inf. Ool. Dundry.

Note.—The specimens described by Davidson were stated by

him to belong to the Bristol Museum, but it is not very clear that the specimens in this Museum so referred are the same.

Crinoidea.

Dichocrinus radiatus, Münster, T. and T. Austin, Mono. Crinoidea, p. 45, pl. v. f. 5 *c* [calyx]. Carb. Limest. ? Loc.

Platycrinus gigas, J. Phillips, T. and T. Austin, Mono. Crinoidea, p. 38, pl. iv. fs. 1*a*, *b*, *c* [calyx]. Carb. Limest. ? Loc.

Platycrinus rugosus, J. S. Miller, T. and T. Austin, Mono. Crinoidea, p. 40, pl. iv. fs. 2 *d*—*k*. Carb. Limest. ? Loc.

Poteriocrinus crassus, J. S. Miller, T. and T. Austin, Mono. Crinoidea, p. 69, pl. viii. f. 3 *c* [column and fragment of calyx]. Carb. Limest. Clevedon.

Synbathocrinus conicus, J. Phillips, T. and T. Austin, Mono. Crinoidea, p. 93, pl. ix. f. 5 [column, calyx and arms]. Carb. Limest. Hook Point, Wexford.

Actinozoa.

Alveolites (*Favosites*) *septosa*, J. Fleming, M. Edwards, and J. Haime, Brit. Foss. Corals, Pal. Soc. p. 157, pl. xlv. f. 5 [a subglobose mass]. Carb. Limest. ? Loc.

Clisiophyllum turbinatum, F. McCoy, M. Edwards and J. Haime, Brit. Foss. Corals, Pal. Soc. p. 184, pl. xxxiii. f. 1 [a short specimen]. Carb. Limest., Clifton.

Clisiophyllum coniseptum, A. Keyserling, M. Edwards and J. Haime, Brit. Foss. Corals. Pal. Soc. p. 185, p. xxxvii. f. 5 [a large specimen partly broken]. Carb. Limest. ? Loc.

Cyathophyllum regium, J. Phillips, M. Edwards and J. Haime, Brit. Foss. Corals, Pal. Soc. p. 180, pl. xxxii. f. 4 [two corallites issuing from the same parent]. Carb. Limest. ? Loc.

Michelinia (*Manon*) *favosa*, Goldfuss, M. Edwards and J. Haime, Brit. Foss. Corals, Pal. Soc. p. 154, pl. xliv. f. 2 [a large broken compound mass]. Carb. Limest. ? Masbury, Mendips.

Michelinia (*Calamopora*) *megastoma*, J. Phillips, M. Edwards and J. Haime, Brit. Foss. Corals, Pal. Soc. p. 156, pl. xliv. f. 3*b* [a polished oblique section]. Carb. Limest. ? Loc.

Michelinia (*Calamopora*) *tenuisepta*, J. Phillips, M. Edwards and J. Haime, Brit. Foss. Corals, Pal. Soc. p. 155, pl. xliv. f. 1 [a small mass]. Carb. Limest., Masbury, Mendips.

Plantæ.

Alethopteris Davreuxi, Brongniart, R. Kidston, Trans. Roy. Soc. Edinburgh, vol. xxxiii. (1888) pt. 2, p. 386, pl. xxiv. f 1. Coal Measures, Camerton.

Caulopteris macrodiscus, Brongniart, R. Kidston, Trans. Roy. Soc. Edinburgh, vol. xxxiii. (1888) pt. 2, p. 393, pl. xxv. f. 1. Coal Measures, Coalpit Heath, Bristol.

Rhacophyllum Goldenbergii, Weiss, R. Kidston, Trans. Roy. Soc. Edinburgh, vol. xxxiii. (1888) pt. 2, p. 388, pl. xxvii. f. 2. Coal Measures, near Pucklechurch, Gloucestershire.

Zoophycos (*Cancellophycus*) *scoparius*, Thiollière, E. B. Tawney, Proc. Brist. Nat. Soc. ser. ii. vol. vii. (1873) pt. 2, pp. 40, 41. Inf. Ool., Rackledown Quarry, Dundry.

List of the Principal Works relating to Fossil "Types" and Described Specimens in the Bristol Museum.

1768. *A. Catcott*, A. Treatise on the Deluge, second ed.

1812-29. *J. Sowerby*, Mineral Conchology of Great Britain.

1821. *J. S. Miller*, A Natural History of the Crinoidea.

1823. *W. Buckland*, Reliquiæ Diluvianæ.

1829. *J. Cottle*, Malvern Hills, with Minor Poems and Essays. 8vo. Fourth ed. 1829, vol. ii.; and reprinted folio ed. with plates, n.d.

1829. *J. S. Miller*, Observations on Belemnites, Trans. Geol. Soc. 2nd series, vol. ii.

1833-43. *L. Agassiz*, Recherches sur les Poissons Fossiles.

1836. *W. H. Fitton*, Observations on some of the Strata between the Chalk and the Oxford Oolite in the South-east of England, Trans. Geol. Soc. 2nd series, vol. iv. with Appendix, Descriptive Notes respecting the Shells figured by *J. de C. Sowerby*.

1840. *H. Riley* and *S. Stutchbury*, A Description of various Fossil Remains of three distinct Saurian Animals recently discovered in the Magnesian Conglomerate near Bristol. Trans. Geol. Soc. 2nd ser. vol. v.; Proc. Geol. Soc. vol. iii.

1840. *R. Owen*, Report on British Fossil Reptiles, Brit. Assoc. Rep. for 1839.

1842. *S. Stutchbury*, On a new genus of Fossil Bivalve Shells, Ann. and Mag. Nat. Hist. vol. viii.

1843 (circa). *T. Austin* and *T. Austin, jun.*, A Monograph on Recent and Fossil Crinoidea.
1846. *S. Stutchbury*, Description of a new species of Plesiosaurus in the Museum of the Bristol Institution. Q.J.G.S. vol. ii.
1852. *H. M. Edwards* and *J. Haime*, A Monograph of the British Fossil Corals, Palæontographical Society.
1854. *J. Morris*, A Catalogue of British Fossils, second edition.
1854-84. *T. Davidson*, British Fossil Brachiopoda, Palæontographical Society, Suppl. to vol. i. vol. iv. and vol. v.
1855. *P. de M. G. Egerton*, Figures and Descriptions illustrative of British Organic Remains, Mem. Geol. Survey of the United Kingdom, dec. viii.
1857. *C. Gould*, Description of a new fossil Crustacean (*Tropifer lævis*, C. Gould) from the Lias Bone-bed. Q.J.G.S. vol. xiii. p. 360.
1865. *J. Phillips*, A Monograph of British Belemnitidæ, Palæontographical Society.
1868. *F. Stoliczka*, Cretaceous Fauna of Southern India, vol. ii. the Gastropoda, Mem. Geol. Surv India, Palæontologia Indica.
1868. *H. Falconer*, Palæontological Memoirs and Notes of the late, edited by Charles Murchison, vol. ii.
1870. *T. H. Huxley*, On the Classification of the Dinosauria, with Observations on the Dinosauria of the Trias, Q.J.G.S. vol. xxvi.
1871. *F. Stoliczka*, Cretaceous Fauna of Southern India, vol. iii. the Pelecypoda, Mem. Geol. Surv. India, Palæontologia Indica.
1874. *E. B. Tawney*, Museum Notes, "Dundry Gasteropoda," Proc. Bristol Nat. Soc. N. S. vol. i. part i.
1876. *J. S. Gardner*, Cretaceous Gasteropoda, GEOL. MAG. Dec. II. Vol. III.
1877. *H. Woodward*, A Catalogue of British Fossil Crustacea in the British Museum.
1878. *L. C. Miall*, Monograph of the Sirenoid and Crossopterygian Ganoids, Palæont. Society.
1879. *W. J. Sollas*, On the Silurian District of Rhymney and Pen-y-lan, Q.J.G.S. vol. xxxv.
1881. *W. J. Sollas*, On a new species of Plesiosaurus (*P. Conybeari*) from the Lower Lias of Charmouth; with Observations on *P. megacephalus*, Stutch., and *P. brachycephalus*, Owen, with Supplement on the Geographical Distribution of the genus Plesiosaurus by *G. F. Whidborne*, Q.J.G.S. vol. xxxvii.
1882. *W. Downes*, The Zones of the Blackdown Beds and their Correlation with those at Haldon, with a List of their Fossils, Q.J.G.S. vol. xxxviii.
1883. *J. W. Davis*, Monograph on the Fossil Fishes of the Carboniferous Limestone Series of Great Britain, from the Scientific Transactions of the Royal Dublin Society, vol. i. series ii.
1883. *G. F. Whidborne*, Notes on some Fossils, chiefly Mollusca, from the Inferior Oolite, Q.J.G.S. vol. xxxix.
1886. *R. Lydekker*, Catalogue of the Fossil Mammalia in the British Museum, Parts iii. and iv.
1887-89 *et seq.* *W. H. Hudleston*, Inferior Oolite Gasteropoda, Nos. 1, 2, 3 *et seq.* Palæontographical Society.
1888. *R. Kidston*, On the Fossil Flora of the Radstock Series of the Somerset and Bristol Coal-field (Upper Coal Measures), Trans. Roy. Soc. Edinburgh, vol. xxxiii. pt. ii.
1888. *E. Wilson*, The Bone Cave or Fissure of Durdham Down, Proc. Bristol Naturalists' Soc. N. S. vol. v.
1888-89. *R. Lydekker*, Catalogue of the Fossil Reptilia and Amphibia in the British Museum, Part 1, Dinosauria, Part 2, Ichthyopterygia and Sauropterygia.
1889. *A. S. Woodward*, Catalogue of the Fossil Fishes in the British Museum, part 1, Elasmobranchii.
1890. *A. S. Woodward* and *C. D. Sherborn*, A Catalogue of British Fossil Vertebrata.

NOTICES OF MEMOIRS.

I.—NOTE ON A FOSSIL FISH AND MARINE WORM FOUND IN THE PLEISTOCENE NODULES OF GREEN'S CREEK ON THE OTTAWA. By SIR J. WILLIAM DAWSON, F.R.S. (Canadian Record of Science, vol. iv. pp. 86–88, April, 1890.)

THE Pleistocene Clays of Green's Creek are well known from the occurrence in them of fish-bearing nodules resembling those

found on the coast of Greenland. *Mallotus villosus*, *Osmerus mordax*, *Gasterosteus aculeatus*, and *Cyclopterus lumpus*, have already been recorded from this deposit; and Sir William Dawson now adds a species of *Cottus*, which seems to be *C. fasciatus* of Reinhardt. Other nodules containing Nereid worms are also described, and believed to represent a species of the genus *Nereis*.

II.—The Occurrence of Radiolaria in Albite Crystals.

A. Issel. Radiolaires fossiles contenues dans les cristaux d'albite. Compt. Rend. tome cx. pp. 420—424, Fevr. 24, 1890.

A. Issel. Il Calcifiro fossilifero di Rovegno in Val di Trebbia. Annali del Museo Civico di Storia Naturale di Genova, (2) ix. 1890, pp. 91—119, pls. v. and vi.

PROBABLY one of the last places in which a geologist would attempt to commence fossil collecting would be in a rock containing authigenous crystals of albite, and perhaps the most remarkable discovery announced in the present year is that not only does such a rock yield a Radiolarian fauna, but that the fossils occur in the albite crystals themselves. The calciphyre, in which this unexpected find has been made, occurs at several places round Rovegno, a village situated in the tongue of Pavia that runs south up the Trebbia valley to the summit of the Ligurian Apennines. The rock occurs in a series of calcareous marls, calcareous and argillaceous "schists" and tiles, belonging to the group of Upper Eocene beds (piano liguriano), which has already yielded so many interesting results. The beds are so much contorted that the stratigraphical sequence is determinable but with difficulty; the fossiliferous rock, however, certainly belongs to the lower part of the series, the upper part of which consists of serpentines, gabbro, diabase, phtanite with pyrolusite, and breccias. The calciphyre occurs intercalated with beds of hard, black, siliceous schist, which together are 6·3 mètres in thickness; the limestone is of a groundmass of ordinary cryptocrystalline calcite, in which are scattered crystals of felspar; these are often minute in size, but range to a length of 3 cm. Their crystallographic and optical properties clearly prove them to be albite. Analyses of the rock and of the insoluble residues are given; these, however, are less satisfactory; thus in the former 10 per cent. of silica is accompanied by only traces of alkalies; hence so much other siliceous matter must be present that little can be learnt from bulk analyses. The Radiolaria occur mostly within the albite, but sometimes a specimen projects above the face of a crystal into the surrounding matrix. That the structures really are Radiolaria there seems little room for doubt. Prof. Issel has had considerable experience in the examination of the Radiolarian fauna of the diaspores that occur in the same series;[1] while the plate of microphotographs that accompanies the second

[1] See, *e.g.* his recent paper, "Dei noduli a radiolarie di Cassagna e delle roccie silicee e manganesifere chi vi si connettono," Atti Soc. Ligus. Sci. Nat. e Geogr. vol. i. No. 1, 1890.

paper seems quite sufficient to settle the question. The fossils are referred to the genera *Ethmosphæra*, *Heliosphæra*, *Caryosphæra*, *Lithopera*, *Spirocampe*, *Dictyomitra*, *Euchitonia*, *Stichocampsa*, and *Polystichia*; *Microlecitos* is a new genus. Moreover, there seems to be no doubt that the albite has been formed *in situ* around the Radiolaria, the material in the chambers of which is often different from that of the albite around it; a halo of less transparent matter also often surrounds the test of the fossil. The limestone shows signs of erosion by acidulated water, and Issel attributes the formation of the calciphyre to hydrothermal agencies acting upon a calcareous marl at or subsequent to the emission of the overlying "anfimorphic" rocks. Hence he concludes "that from this we see that the formation of large crystals of felspar in the heart of a sedimentary rock may be a local phenomenon produced independent of the cause to which metamorphism is by many attributed." J. W. G.

III.—"*Ichthyosaurus campylodon* e Tronchi di Cicadee nelle Argille scagliose dell' Emilia." By Prof. G. Capellini. [Mem. R. Accad. Sci. Istit. Bologna, ser. 4, vol. x. (1890), pp. 1-24, pls. i. ii.]

In the Bulletin of the Italian Geological Society last year (vol. viii. pp. 43–45), Prof. D. Pantanelli announced the discovery of Saurian jaws in the supposed Eocene beds of Emilia, determining them to be Crocodilian, and applying to them the name of *Gavialis mutinensis*. Prof. Capellini now gives good figures and a detailed description of the fossil in question, proving that it is a fragment of the snout of *Ichthyosaurus campylodon*, and must have been derived from the Cretaceous formation. The Professor is also engaged at present, in collaboration with Prof. Solms Laubach, upon a monograph of the fossil Cycads of Emilia: he thus adds a description and figure of a Cycadean stem from the same horizon as the Ichthyosaurus snout, proposing for it the name of *Raumeria masseiana*.

REVIEWS.

I.—The Connexions of the Animal World in Geological Times.

Les Enchainements du Monde Animal dans les Temps Geologiques—Fossiles Secondaires. By Albert Gaudry. pp. 523, and 403 Woodcuts. (Paris, 1890.)

With this volume we have the third, and we presume the final, part of Prof. Gaudry's 'Enchainements'; and its appearance would seem to indicate that the work as a whole has been a financial success. If such a work were published in this country, we confess we should be rather at a loss to indicate the class of readers to whom it would be acceptable, since it makes no pretence to be a scientific and detailed palæontological manual, and yet appears to be too

descriptive and technical for the ordinary reader desirous of obtaining a smattering of science. It is, however, quite probable that France may have a class of readers unrepresented among ourselves.

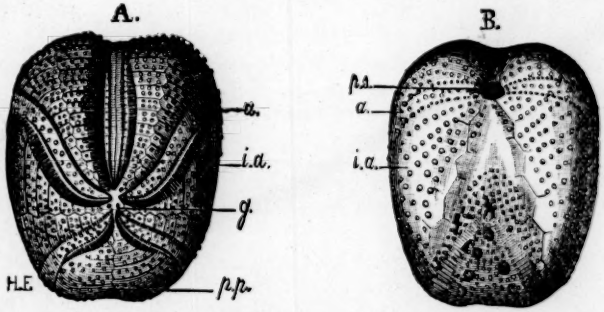

FIG. 1.—Upper (A) and lower (B) surfaces of the test of *Heteraster oblongus*; from the Neocomian.

The great feature of this, as of the preceding volumes, is the beauty and number of the illustrations, all of which are by M. Formant, whose name alone is sufficient guarantee for their excellence. By the courtesy of the author we are enabled to give specimens of these illustrations taken from various classes of the animal kingdom, so that our readers may judge for themselves.

The introductory chapter gives a valuable table of the various horizons of the Mesozoic rocks of France. The second chapter is devoted to the Foraminifera, the third to the Corals, and the fourth

FIG. 2.—Shell of *Ostrea macroptera*; from the Neocomian.

to the Echinoderms. We notice that in the latter group not only is the minute structure of the test and of the 'lanthorn' very fully illustrated, but figures are given of nearly all the main types of form found in the test of the Urchins; we select *Heteraster* (Fig. 1) as a sample of the illustrations in this chapter. The Molluscs, as their importance deserves, have a long chapter to themselves, which is very fully illustrated. Fig. 2, taken from this chapter, strikes us as a first-rate example of wood-engraving. We notice that in the *Ostreidæ* the author regards *Gryphæa* merely as a subgenus of *Ostrea*, and certainly the series of figures given on page 77 goes far to support this view. In the Gasteropoda it is curious to note how *Malaptera* (fig. 60), of the Corallian, seems to be a more specialized type derived from the Oxfordian *Pteroceras* (fig. 156) by the 'webbing' of the spaces between the 'fingers.' In the Ammonites

the author adopts as genera the numerous terms which have been proposed of late years, and figures several specimens (figs. 190, 191) exhibiting the rare feature of the complete mouth. The figures of the various modifications of the sutures of the lobes given on pp. 114, 115, will be found interesting and instructive.

Passing by the sixth chapter, which is devoted to the Brachiopods and Arthropods, we commence the Vertebrates with the seventh chapter; these occupying the remainder of the volume. In the

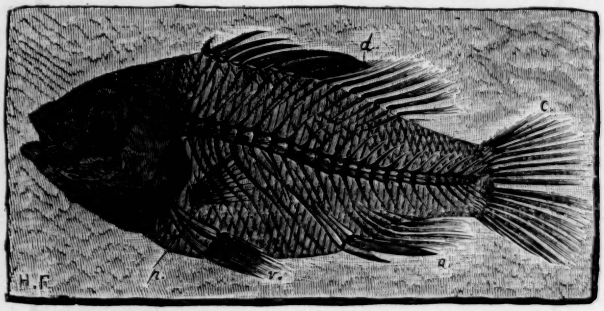

FIG. 3.—Skeleton of *Lates Heberti;* from the Pisolite of Mt. Aimé. $\frac{1}{2}$ nat. size.

chapter on Fishes the author traces the gradual tendency to a loss of a bony scale-armour as we advance in geologic time, and likewise the gradual increase in the degree of ossification of the endo-skeleton. We have selected the figure of the skeleton of *Lates* (Fig. 3), and of the jaw of *Mesodon* (Fig. 4) as good specimens of the illustrations in this chapter.

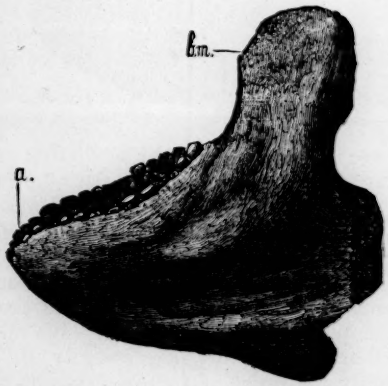

FIG. 4.—Outer side of the left ramus of the mandible of *Mesodon profusidens*; from the Neocomian. $\frac{3}{4}$.

Under the heading Reptiles the author includes both the animals properly so called and also the Amphibians. In treating of the Labyrinthodonts, the Professor expresses strong doubts whether the

footprints described as *Chirotherium* are really due to members of this group, and inclines to the view that they were more probably made by Dinosaurs. We venture to think that the interesting group of Anomodonts (including the Theriodonts) are dismissed with too brief a notice on pp. 178-179. In the Ichthyosauria we note with interest another example (fig. 275) showing a fœtus *in ventre*; the specimen does not, however, belong to *Ichthyosaurus tenuirostris*, and should apparently be referred to *I. acutirostris*. In comparing (p. 194) the structure of the limbs of *Ichthyosaurus* and *Pliosaurus*, we must totally differ from the suggestion that there can be any possible genetic relationship between the two genera, the former having evidently descended directly from forms allied to *Plesiosaurus*, with which *Ichthyosaurus* has no sort of connexion. Good figures of the skulls of *Nothosaurus* and its allies are given on page 196, one of which we reproduce in Fig. 5. We observe that the author leaves

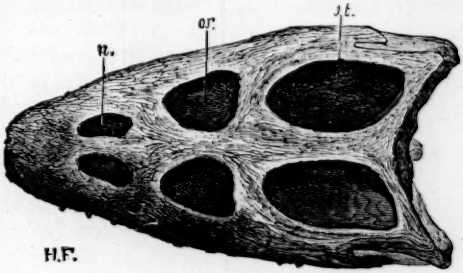

Fig. 5.—Upper surface of the skull of *Simosaurus Guillielmi*; from the Muschelkalk. *n.* nares; *or.* orbit; *st.* supratemporal fossa. ¼ nat. size.

Placodus and *Cyamodus* in the neighbourhood of *Simosaurus*, somewhat naively confessing (p. 190) that he does not know what an Anomodont or a Theriodont really is; and thereby, in regard to the latter group, merely repeating a similar confession made by a learned English palæontologist in 1880.[1]

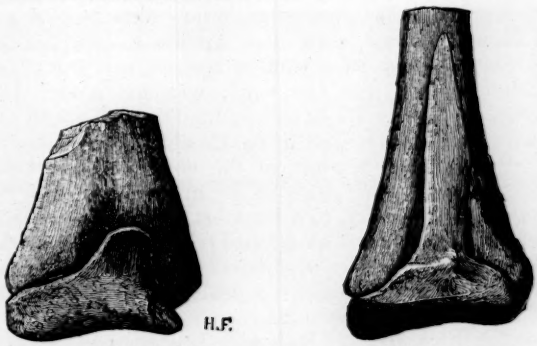

Fig. 6.—Anterior surface of the distal end of the tibia and astragalus of *Megalosaurus* and a young Ostrich. Reduced.

[1] Quart. Journ. Geol. Soc. vol. xxxvi. p. 543.

In the section on the Dinosaurs the figure of the tibia and astragalus of *Megalosaurus*, which we reproduce in Fig. 6, shows very clearly the close resemblance presented by the mutual relationship of these bones to those of the young Ostrich. Why, however, the author should have gone out of his way to suggest that in both these instances the astragalus is but an epiphysis of the tibia we are somewhat at a loss to understand. In the same group the figures of the bones of *Dimodosaurus*—a Dinosaur hitherto unknown to us—are of interest as showing the apparently close relationship of that form to *Thecodontosaurus* and *Anchisaurus*. Judging, however, from Prof. Marsh's figures of the hind foot of the latter, there is some error in the restoration of the foot of *Dimodosaurus* given on p. 219 of the work before us.

Space does not permit of a detailed notice of the remaining portion of the text devoted to the other Reptiles, nor of the chapters on *Archæopteryx* and the Mesozoic Mammals. We cannot, however, pass without notice the comparison on pp. 244, 245, between Pterodactyles and Bats; and the suggestion, however guarded, of any affinity between the two. Here the author does not seem to know his own mind; either Pterodactyles or Bats are or are not connected; if they are, well and good; but if they are not, we fail to see how the former can in any sort of way lessen the interval dividing Mammals from Reptiles.

We offer our congratulations to the Professor on having at length reached the end of the long task he has set before himself. R. L.

II.—The Life and Letters of the Reverend Adam Sedgwick, LL.D., D.C.L., F.R.S., etc. By J. W. Clark, M.A., F.S.A., and T. McKenny Hughes, M.A., F.R.S., etc. Two vols. 8vo. pp. 539, 640; with Portraits, Maps, and other Illustrations. (Cambridge, at the University Press, 1890.)

IT is well that the Biography of Adam Sedgwick has been published, for no one can read the record of his life without feeling the better for it. Seventeen years have passed since the "First of Men" (as Sedgwick was known among his scientific associates) passed away from earthly scenes; and there is indeed some reason to regret that the work was not sooner published. Intimate friends of Sedgwick have lamented the delay, and geologists who are more or less interested in the Cambro-Silurian controversy, have wished for a fuller account of the circumstances which for a number of years obscured much of the great work done by Sedgwick. His claims, however, to a foremost place among the founders of our science have not been questioned; his particular work now-a-days receives adequate acknowledgment; and as the years roll by there is a growing disposition to deal amicably with the vexed subject of Palæozoic nomenclature.

So far as the Biography of Sedgwick is concerned, we question if the delay has been at all prejudicial. Prof. Hughes, who originally took in hand the task, found himself unable to devote the necessary

time to the work, and fortunately secured the skilled help of Mr. Clark, to whom we owe the greater portion of the two volumes. Thus, more ample justice has been done to the life and times of Sedgwick, than could have been the case with a less exhaustive collection and consideration of the materials; and there are many who hold that the life of a man should not be published until at least twenty-five years after his death.

Not geologists alone, but all to whom biography has attraction, will welcome these volumes, bringing before us as they do the chief incidents in the life of "a Master among Philosophers" and "a singularly genial and loveable man." The accounts which Sedgwick himself has given of the manners and customs of the people of Dent, where he was born in 1785, form one of the most attractive portions of the first volume. To this Yorkshire village he returned again and again in after-life, ever regarding it with affection. In old times "there was kept alive a feeling of fraternal equality" among the several classes of inhabitants; and while there still lived some who had known Sedgwick in his youth, he never visited Dent without hearing his Christian name uttered by the dalesmen.

One of his early employments on a half-holiday during the period he attended the Grammar School at Dent, was to collect the conspicuous fossils of the Mountain Limestone of his native valley. While, however, these rambles aided to establish a taste for out-door observations, it was many years before Sedgwick gave any systematic attention to geology. Proceeding to Cambridge in 1804, he entered Trinity College, and was admitted to the Degree of Bachelor of Arts in 1808, when his name stood fifth in the first class, or Wranglers. We may pass briefly over his early college experiences, but it is important to mention that he overworked himself in preparing for his Fellowship examination, and the chronic ill-health from which he suffered during the rest of his life may be traced to the strain he endured during this period. For several years he was occupied as Private Tutor and afterwards as Assistant Mathematical Tutor at Trinity College.

His wish had been to read for the Bar, but as it became necessary to create an independence for himself as soon as possible, he was led to enter the Church, for which, at the time, he had no very decided inclination. Indeed, his resolution to read divinity was not at first carried out with much vigour, for it appears that in the following vacation Boswell's Life of Johnson was the only book that occupied his attention. His work, however, at this time, whether mathematical or theological, did not arouse his enthusiasm; he felt his life to be one of rather dull uniformity, while his health unfitted him, now and in after-life, for long continued sedentary labour. During holiday excursions in 1813 we find him visiting the iron-mines of Furness and the copper-mines near Coniston; but two years later, at Dent, geology had not gained his affections, for he was constantly out on the moors, where he "killed a good many birds." In 1817 he was ordained Deacon, and in the following year he was admitted to Priest's Orders.

Now came the crisis of his life. Sedgwick was thirty-three years of age, when it was announced that the Rev. John Hailstone, who had been Woodwardian Professor of Geology since 1788, was proposing to vacate the office. Sedgwick had no special claims to justify him in becoming a candidate; he desired a motive for active exertion in a way that would promote his intellectual improvement. He was opposed by Gorham (subsequently of controversial fame), but Sedgwick, who was supported, as a man of talent, by his College, polled 186 votes against 59 of his rival. Sedgwick remarked, "Hitherto I have never turned a stone; henceforth I will leave no stone unturned," and the energy and enthusiasm with which he set to work is well told in these pages. His earliest lessons were taken alone in the field, with the maps of William Smith in his hand, when he traversed on foot the Cretaceous and Oolitic rocks of Wiltshire and Somersetshire. To quote from the volume before us, "He always contrived to combine a large amount of amusement with business. 'That lively gentleman Mr. Sedgwick,' as he was called by a stranger who met him in a stage-coach, had a happy knack of making himself agreeable to everybody with whom he happened to be brought into contact, and his geological tours gave him a wide and varied experience of mankind. With all sorts and conditions of men, quarrymen, miners, fishermen, smugglers, shepherds, artisans, grooms, inn-keepers, clergy of all denominations, squires, noblemen—he was equally communicative, and soon became equally popular. He could make the most silent talk, and could extract information and amusement out of materials that seemed at first sight destitute of either quality."

We are told how he made acquaintance with J. J. Conybeare, and afterwards with his more distinguishished brother W. D. Conybeare, whom Sedgwick came to regard as his Master in Geology. As early as 1819 he began to make original observations, and between that date and 1827 he explored much of the West of England, Yorkshire, Durham, and the Lake District. Accounts of his journeys are communicated in letters; and indeed throughout his life, Sedgwick was a capital letter-writer. The records of these early investigations are especially interesting, for Sedgwick explored the districts for the most part on foot, carrying heavy burdens of rocks and fossils, and finding shelter after the labours of the day at one of the country inns. Occasionally we find him accompanied by Henslow or Whewell; but his chief work in early years was done alone. When at Cambridge, "He was probably the most popular man in the college, and his rooms the chief centre of attraction. Intimate friends were glad, when their own work was over, to enjoy his original conversation, and not seldom his extravagant fun. . . . Of the leading men in Cambridge sixty years ago, no one made so lasting or so favourable an impression on all who were brought into contact with him as Sedgwick."

We must, however, pass rapidly over the many interesting topics that are brought forward in these volumes. Throughout his life much of Sedgwick's time was occupied in matters relating to his College

or the University; he became Vice-Master of Trinity College, and Secretary to the Chancellor (Prince Albert); and he took a prominent part in election contests. His geological work shows how "by steady application a man of talent may be able to make observations of the first order in the field two years after commencing the study of the subject." He was, however, slow to publish the results of his labours, and sometimes four or five years elapsed before his observations were worked out. His acquaintance with Murchison commenced in 1827, and the two friends were soon journeying together to the Highlands, and ultimately to parts of Wales and Devonshire. If it is regretted that Sedgwick never married, and indeed refused, in 1832, a comfortable living in the south of England, it may be questioned if he would have done more for science (as Lyell suggested), for he could not then have continued his long and arduous excursions. His friend Conybeare writes in 1828: "I shall not be very efficient in the field, for I have not, from the demands of a large family, either time or funds for much touring."

Particular accounts of Sedgwick's work in Wales are given, with facsimiles of some of his MS. sections; and when he had practically completed his explorations in 1846, at the age of 61, he says he had the precise general views he had at the end of 1832, of course with infinitely improved details and better sections. It was not, however, till 1852 that matters were entirely cleared up, when the Caradoc Sandstone, which had been the main source of difficulty and confusion, was clearly separated from the May Hill Sandstone by Sedgwick, with the aid of M'Coy. The unfortunate association of these strata by Murchison was doubtless the cause of the Cambro-Silurian troubles, and Murchison admits that it was not he "who *made Cambrian into Lower Silurian*, but the Government surveyors and palæontologists." Sedgwick's views, too, became misinterpreted, owing to unauthorized alterations in one of his papers published by the Geological Society, so that De la Beche was led to remark to him, "Sedgwick, you have given up a very good nomenclature!"

Geologists now in the Biographies of Sedgwick and Murchison have ample material in which to read the history of the great work done by these old masters. In his latest work, Sedgwick thus speaks of the "Silurian System" of his comrade:—"But the chief honour will ever be given to the author of the System, who brought the materials together and arranged them in that manner in which they are seen in his splendid work. Under his hands the older Palæozoic Geology had assumed a new and nobler type." These generous words, penned by Sedgwick the year before he died, urge us to deal in the same spirit with the respective claims of Sedgwick and Murchison to fix the nomenclature of our older Palæozoic rocks. The order of succession is not in dispute. The claims of science stand before purely personal matters. A threefold division of these rocks has been found most convenient, so that the new term Ordovician, proposed in place of the Upper Cambrian of the one author and the Lower Silurian of the other, has been widely adopted. By its use students at once understand the series of strata

it implies, and if it fails to satisfy the particular advocates of Sedgwick and Murchison, this itself is an indication that justice has been done.

Sedgwick's whole life was dominated by an intention to write a general work upon the Palæozoic rocks of this country. His health, however, and his many engagements prevented his giving sufficient energy and time to the accomplishment of this particular work. The second volume of his Biography is largely occupied with his life at Norwich, at which place he resided for a portion of each year from 1834, when he was appointed to a Prebendal Stall in the Cathedral. The life in the old city was congenial, and as a friend writes, "Under his roof we learnt the true meaning of the word 'hospitality.'" Canon Robinson contributes a chapter dealing with the life at Norwich which is full of interest. Some of Sedgwick's stories are there narrated, including the account of "The Lady and the Shilling." This is given as happening in Wales. In Caroline Fox's "Memories of Old Friends" (Ed. 2, 1882, vol. i. p. 70) the incident is mentioned, as happening to Sedgwick when walking from Falmouth to Truro; and Miss James, an eccentric lady, is stated to have given him the shilling, and to have met him at dinner the same evening.

The volumes contain several touching and amusing anecdotes, as well as reminiscences of famous men and women, of Wordsworth, Jenny Lind, Livingstone, and many others, and accounts of visits paid to the Queen and Prince Albert. There is a history of the old Woodwardian Professors, and a portrait and biography of John Woodward: but we must refer our readers to the volumes for accounts of these and many other interesting matters which space would not allow of our mentioning.[1]

III.—The Geological Features of the North Staffordshire Coal-Fields, their Organic Remains, their Range and Distribution; with a Catalogue of the Fossils of the Carboniferous System of North Staffordshire." By John Ward, F.G.S. [Trans. N. Staffs. Inst. Mining and Mechan. Engineers, vol. x. 1890, pp. 1–189, pls. i.–ix.]

FOR the last thirty years the author of the present volume has been engaged in investigating the stratigraphy and palæontology of the North Staffordshire Coal-fields. During the progress of the Geological Survey of the area in question, Mr. Ward rendered much aid in matters which none but a constant observer upon the spot could satisfactorily elucidate; and for many years his unique collection of Coal-measure Fishes has formed the basis of important memoirs by the late Sir Philip Egerton, Prof. John Young, and Dr. R. H. Traquair. The whole of the collecting has been carried on systematically, each fossil being marked with the name of the

[1] A short biography of Sedgwick, accompanied by a portrait, and list of his principal papers, was printed in the Geol. Mag. for April, 1870, p. 145. The year of his birth is there given as 1784; it should be 1785.

precise stratum from which it was obtained; and while most groups of organisms occurring in the British Coal-measures are well represented, the fish-remains are especially valuable as displaying so many anatomical details that are rarely shown in other collections.

A general summary of the results of such patient investigations is always welcome; and the work before us has the appearance of no hurried sketch, but of a fully matured series of conclusions. The Stratigraphical Section occupies half the volume and embodies the author's personal observations; while in the Palæontological Section the assistance of several well-known specialists has been secured, Mr. R. Kidston having determined the plants, Mr. R. Etheridge having described and determined many of the invertebrate fossils, while most of the novelties among the Ganoid fishes are treated by Dr. R. H. Traquair.

The district described is bounded on the eastern margin by the Carboniferous Limestone of Derbyshire, on the southern and western margins by the Lower Permian and Triassic formations; and some preliminary remarks are offered on the surrounding Lower Carboniferous and Permian deposits before entering upon the proper subject of the work. Four distinct basins are recognized:—the Pottery Coal-field, that of Wetley and Shafferlong, that of Goldsitch Moss, and that of Cheadle. Each of these is described in detail, with numerous pit-sections and lists of fossils, almost all of which are now for the first time published. The total vertical thickness of the coal- and ironstone-bearing strata in the Pottery Coal-field is about 3951 feet; the Wetley and Shafferlong Coal-field is comparatively insignificant; the corresponding measures of Goldsitch Moss are not of much commercial value, and probably do not exceed 700 feet in thickness; while the Cheadle Coal-field is also small, though comprising twelve workable seams of coal of an aggregate thickness of over 40 feet, besides a valuable bed of hæmatite which is mined at the base of the series. All the more important horizons are described with their local names; and an attempt is made to divide the measures of each Coal-field into an Upper, Middle, and Lower group. For the most part these details will be appreciated by the mining engineer rather than by the ordinary geologist; but the interest of the latter is sustained by the series of lists of the fauna and flora, which indicate the various changes in physical conditions during the deposition of the successive beds.

The "Catalogue of Organic Remains" is systematically arranged, the principal literature-references, besides localities and horizons, being appended to each species from the Coal-Measures. Among the Mollusca, two new species, *Anthracomya Wardi* and *Sanguinolites granulatus*, are described by Mr. Etheridge, and the last mentioned is also figured. On the same plate several other Molluscs of the genera *Anthracosia*, *Anthracomya*, *Modiola* and *Goniatites*, are likewise well illustrated, in addition to species of *Discina*, *Chonetes*, and *Lingula*, and part of the spiny Myriapod, *Euphoberia*. More detailed notices of the Fishes and Amphibia are given, and these form the subject of no less than eight plates, of which one is large and

folded. Among Elasmobranch Fishes, *Orthacanthus* is retained as a genus distinct from *Pleuracanthus*; a new form of tooth is named *Diplodus equilateralis*; and a specimen of *Ctenoptychius apicalis* is described as showing minute dermal tubercles, but no fin-spines. *Ctenodus Murchisoni* is briefly described for the first time; and *Dendroptychius* is relegated to the synonymy of *Strepsodus sauroides*. A description of *Megalichthys pygmæus*, sp. nov., is contributed by Dr. Traquair, with figures; and to the same ichthyologist, or to Mrs. Traquair, are due several drawings of Palæoniscid and Platysomid Fishes, notably those of *Elonichthys microlepidotus*, *Gonatodus Molyneuxi*, *Rhadinichthys Wardi* and *Platysomus parvulus*, all of which appear for the first time. Brief notes on the Labyrinthodonts conclude the catalogue, and these are illustrated by figures of *Keraterpeton Galvani*, and a mandibular ramus of *Loxomma Allmani*.

The North Staffordshire Institute and their publishers are to be congratulated on the excellent style in which this volume is issued; and it is to be hoped that at least the palæontological aspect of the subject will be still further treated by Mr. Ward in more special publications. A. S. W.

IV.—Wisnioski, Thaddeus. Mikrofauna ilów ornatowych okolicy Krakowa. Część 1. Otwornice górnego Kellowayu w Grojcu. [Foraminifera of the Kelloways Beds of Grojce.] *Pamietnik Ak. Umiej. Krakowie*, vol. xvii. 3 plates. (1890.)

THE author describes the rich foraminiferal fauna of the Kelloways beds (Callovian) of Grojce. These marls, about six feet thick, are on the horizon of *Cosmoceras ornatum* (Schloth.), and we are already indebted to M. Teisseyre for a description of the Cephalopoda found therein. The author notes 124 "species" of Foraminifera, 60 of which he unfortunately sets down as "new." With most of these determinations we are forced to disagree; and cannot help feeling that many of them might have been correlated with forms previously described, the well-known variation in the test of these simple animals having been shown to have but little specific or even generic value by Parker and Jones, Brady, Goës, and other authors, who, from a long and careful study of the recent forms, have contributed so much to the reduction of the "species" of earlier authors. We regret, therefore, that recent writers, who have not the same advantage of studying fine collections from present-day deposits, do not hesitate to name as specific the smallest individual variations. Thus figs. 29 to 36 of pl. ii. (ix.) in M. Wisnioski's paper cannot be referred to more than one and the same "species," the variation being merely individual; and the same may be said of figs. 7 to 16 and 18 to 20 of the same plate. Fig. 28 of plate iii. (x.) is a true Cristellarian, as evidenced by the characteristic mouth shown in fig. *b*.; figs. 1, 3, 4, 5, and 11 of pl. iii. (x.) also all belong to one "species"; and it is difficult to imagine how the author arrives at the conclusion that he is here dealing with distinct species. We are much indebted to M. Wisnioski for figuring these

Jurassic Foraminifera; but have felt bound to call attention to such unnecessary multiplication of specific names in a group already so largely complicated by this faulty treatment. We do not now name as new every slight variation of hair or feathers in the Vertebrata; and the surface-markings and shape of the Foraminifera are almost exactly parallel in value. A brief abstract in French will be found in the *Bull. Ac. Sci. Cracovie*, for February, 1890. C. D. S.

V.—On some Australian Species of the Family Archæocyathinæ. By R. Etheridge, jun., Palæontologist to the Australian Museum and Geological Survey of N. S. Wales. Transactions of the Royal Society of South Australia, 1890, pp. 10–22, pls. ii. iii.

HITHERTO the fossils belonging to this family have only been definitely known from the Cambrian strata of Labrador, New York State, Nevada, Spain, and Sardinia, although some badly-preserved specimens from supposed Devonian rocks of New South Wales were referred many years since by Prof. De Koninck to the genus *Archæocyathus*. These fossils have unfortunately since been destroyed by fire, so that their real nature must remain undetermined; but if they were correctly referred to the above genus, the rocks from whence they come are probably much older than the Devonian period. That forms closely allied to *Archæocyathus* do, however, occur in Australian rocks, is very conclusively shown in the present paper, which contains descriptions of new species of *Ethmophyllum*, *Coscinocyathus* and *Protopharetra*, hardly to be distinguished from the typical forms of these genera in the rocks of North America and Sardinia. The Australian fossils are from limestone strata at Ardrossan, Yorke's Peninsula, Kanyka, north-east of Porth Augusta, and some other localities in the Flinders Range still further to the north;—all in the colony of South Australia. The specimens are for the most part imbedded in the hard rock, and can therefore only be studied in sections; not only in form but also in mineral structure they show a close similarity to specimens from Sardinia and North America, and this resemblance is not limited to the fossils merely, but includes the matrix as well, so that hand-specimens of the *Archæocyathus* limestones from Yorke's Peninsula could scarcely be separated from pieces of rock similarly filled with these organisms, from the Labrador coast or from Sardinia.

Owing to the way in which the fossils are preserved, it is very difficult to ascertain specific details, and Mr. Etheridge has acted wisely in not increasing the number of species on necessarily imperfect data; but it is probable, considering the great number of specimens in the rock, that further forms will yet be made out. The geological horizon of these Australian *Archæocyathus* limestones —or at all events those from Yorke's Peninsula—has already been determined by the presence in them of Trilobites referred by Dr. H. Woodward to the genera *Dolichometopus* and *Conocephalites* and allied to species from the Potsdam strata of New York (Geol. Mag. 1884, pp. 342–344), and the correctness of this reference is now con-

firmed by the occurrence of the Archæocyathinæ, which are likewise associated with similar Cambrian Trilobites in New York and Canada. In Dr. Woodward's paper the relationship of the *Archæocyathus* forms was not recognized, but they were supposed to be Corals.

Mr. Etheridge further describes some peculiar microscopic tubuli, referring them doubtfully to *Girvanella*. Similar forms have been noticed by Dr. Bornemann in the Cambrian strata of Sardinia.

This paper is an important contribution to Australian geology, as it definitely proves the existence in that continent of a well-marked horizon of Cambrian rocks closely corresponding to the Lower Cambrian of the Northern Hemisphere.

CORRESPONDENCE.

WIND WAVES AND TIDAL CURRENTS.

Sir,—Mr. T. Mellard Reade, in putting before the readers of the Geological Magazine his views on the origin of the Lower Trias (Geol. Mag. Feb. April, and June, 1890) drew from Mr. Arthur R. Hunt, F.L.S., a letter on "Tidal Action," in which the latter denies the power of tidal currents to do the work invoked by Mr. Reade in his theory of the *marine* origin of the pebbles of the Bunter.

Mr. Hunt writes (Geol. Mag. April, 1890, p. 191) as follows: "It may be well to point out one line of evidence which seems to have been overlooked by the supporters of the tidal theory, *i.e.* the zoological." He gives the English Channel as an excellent test case, and remarks, that "if unchecked tidal currents are anywhere resistless, they should be so here. Do these tidal currents disturb the gravel, or sand, or even the mud on the Channel bottom? The marine fauna of the district answers this question with an emphatic negative." And again, "The presence of this Molluscan fauna in these very exposed localities is good proof that unchecked tidal currents sweeping over a fairly level sea-bottom are incapable by their own unassisted efforts of raising the sand."

Now without entering into the discussion of the main question raised by Mr. Reade, I beg to offer the following observations on the line of evidence suggested by Mr. Hunt, viz. the power of wind waves and tidal currents to disturb the sand or mud of the sea-bottom. To this end, I quote the *practical* experience of a well-known French marine zoologist, M. Hermann Fol, of the zoological laboratory at Nice, who in his yacht "Amphiaster," was, last year, entrusted with a mission by the French Minister of Public Instruction, to explore, from a zoological point of view, the littoral of Corsica and Tunis.

M. Fol is in the frequent habit of donning the diver's dress and descending to depths of from 30 to 100 feet and upwards in search of marine organisms. Quoting from a recent paper (Rev. Sci. June 7th, 1890) M. Fol says, "When there is a swell on the water, the task of the diver becomes very difficult. He is constantly tossed

about in spite of himself and an irresistible force makes him oscillate like a pendulum.

This see-saw motion of the water, which is the counterpart of the swell on the surface, is felt nearly as much at 30 mètres (99 feet) as at 10 mètres of depth.

It cannot be attributed to the surf, due to the vicinity of the coast, since the fishermen who use trawl or drag net upon extensive banks, situated quite out at sea, know that after a storm, these banks at 50 ms. (164 feet) *and more, below the level of the sea, are completely swept clear of their usual inhabitants.*"

If, then, the movement of the water, as described by M. Fol, is felt at such depths in the Mediterranean Sea, how much more powerful must be the storms or currents of the English Channel to disturb gravel or sand, or temporarily displace the marine fauna? The fact that Molluscs still exist in an area swept by occasional storms and open to currents generated by tidal waves seems scarcely to warrant Mr. Hunt's assumption that tidal action has no influence whatever on the sea-bottom.

MARK STIRRUP.

BOWDON, CHESHIRE.

OBITUARY.

WILLIAM KITCHEN PARKER, F.R.S.

BORN JUNE 23, 1823; DIED JULY 3, 1890.

THE late and deeply lamented Professor William Kitchen Parker, F.R.S., F.L.S., F.R.M.S., etc., was born June 23, 1823, and died suddenly July 3, 1890. He was a Biologist in the widest sense of the term, having systematically studied all grades of living organisms in both the Vegetable and the Animal World. His life throughout, from boyhood onward, was largely devoted to the study of the bony structure of Vertebrates, but botanical research in early days, and a wide examination of rhizopodal organisms, were rival pursuits, until his energies, well and bravely continued through ill-health, were more especially given to the elucidation of embryonic morphology, or the developmental growth of the skull and other parts of the Vertebrate skeleton. The results of this long-continued and enlightened study gave him a world-wide reputation; and his lines of research in this pursuit, grounded on the work already done by Rathke, Gegenbauer, and Huxley, have led to a great advancement in Biology, both for professors and students.

Geologists are indebted to Professor W. K. Parker's knowledge of Osteology for thoughtful notes on the Archæopteryx (GEOL. MAG. 1864, pp. 55–57), and on Fossil Birds from the Zebbug Cave in Malta (Proceed. Zool. Soc. 1865, and Trans. Zool. Soc. 1869); and his perfect acquaintance with Rhizopoda was shown in the treatment of several series of fossil Foraminifera, in joint papers with others. His rhizopodal studies were taking shape in 1856 (and probably before), when, examining fresh marine material from Bognor, and much larger supplies from Sponge-sands, and from among East-